MACHINERY.

May, 1908.

A 2,000 H. P. GAS ENGINE BLOWING UNIT.*

ONE of the great changes going on in power plant equipment is the use of large gas engines and steam turbines in place of the reciprocating steam engine. The internal combustion engine and steam turbine are slowly but surely supplanting the reciprocating steam engine except for such service as reversing rolling mills and mine hoists. In other fields it apparently has an unpromising future. When the old steam engine is displaced, the fight will be on between the gas engine and the turbine. Considerations of economy incline the engineer to believe that the gas engine will be the favorite motor of the future.

Only a few years ago the internal combustion motor was, at best, considered of comparative inconsequence, its field being limited to motor boats, small power plants, etc. Even in 1893 there was exhibited at the Columbian Exposition a gas engine of about 100 H. P. which attracted much attention because of its large size. Now gas engines of 2,000, 3,000 and even 4,000 H. P. are in use, giving performance much more economical than is possible with the best steam plants using superheated steam. Of particular interest is the use of gas engines in steel plants and blast furnaces, because of the great economy afforded by the use of blast furnace gas. Instead of permitting this valuable fuel, aggregating thousands of horse-power in plants of ordinary size, to be worse than wasted, it is piped away to scrubbers and washers where the dust is so thoroughly removed that it is commonly freer from suspended impurities than the atmosphere. Delivered to the engines, it is quite capable of turning every wheel in the plant, lighting every lamp, compressing the blast and (were it not for the mechanical difficulties of reversing) the entire power of a steel plant could be derived from the gases of the blast furnaces.

The illustrations show a Westinghouse 2,000 H.P. gas-engine-driven blowing engine recently built for the Edgar Thompson plant of the Carnegie Steel Co., Pittsburg, which will serve as an example of recent gas engine and blowing engine development. The blowing cylinders are of particular interest because of the novel way in which clearance is reduced to a minimum and the inlet valves mechanically operated. This construction, known as the "Slick air tub," is one of several schemes for preventing wire drawing of the incoming air because of having to lift inlet valves. Opening the valves by power effects a considerable economy of operation, and increases the volumetric capacity.

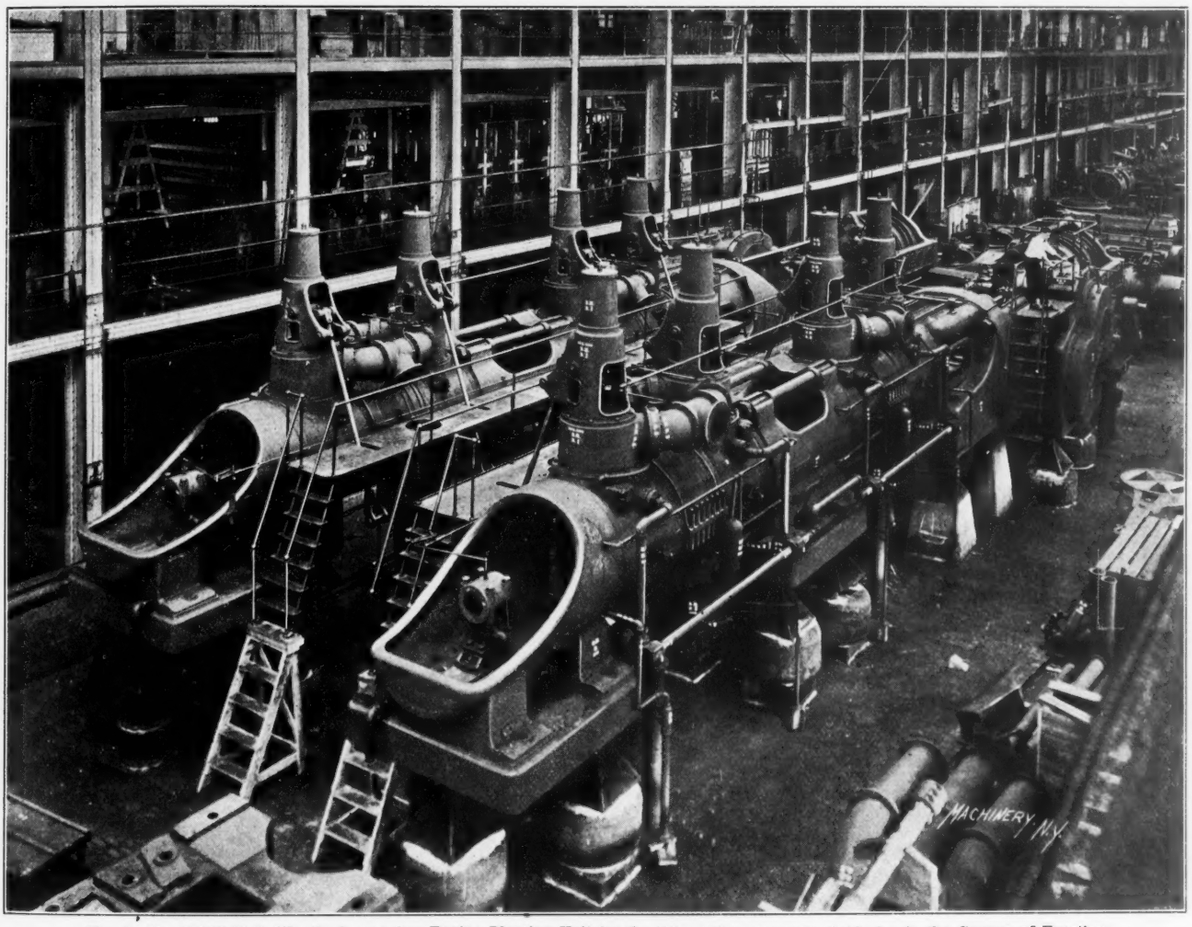


Fig. 1. The 2,000 H.P. Westinghouse Gas Engine Blowing Unit for the Edgar Thompson Steel Works, in the Course of Erection in the Shops of the Builders.

These engines are of the 4-cycle type, with two double-acting horizontal tandem cylinders acting on each of the two cranks; this gives four power strokes per revolution, the cranks being set ninety degrees apart. The cylinders are each 40 inches in diameter, and 54 inches stroke. The speed ranges from 65 to 75 revolutions per minute. The engines are intended for blowing service for the Bessemer converter plant, the blowing cylinders being of the "Slick air tub" type, which will be described later. Their capacity is 25,000 cubic feet of free air per minute, at a normal pressure of 18 pounds per square inch, running up to a maximum of 25 pounds. On blast furnace gas the brake horse-power is 2,400, which is increased to 3,100 when natural gas is used.

* For additional information on this subject, see the article on "Four 4,000 H. P. Gas Engines," published in the January, 1908, issue of MACHINERY, and other articles there referred to.

The Crank-shaft and Bearings.

The side crank construction is employed. This has the advantage of requiring but two bearings, which are easily aligned. As shown in Fig. 3, the shaft is solid, with solid cast steel cranks mounted on it. An unusual feature of the design is the fact that the pins are cast integral with the cranks, as shown in Fig. 4, thus avoiding the possibility of straining the metal between the crank-pins and the shaft in making press fits. The crank disks are cast with the crank-pins at the bottom of the core, thus insuring solid metal at this point. The dot and dash lines in Fig. 4 show the contour of the rough casting.

The main bearings, seen best in Fig. 2, are made in four parts, of which the two side pieces are adjustable by wedges. The two sides of these bearings are held together by tie-rods, passing through from side to side above the shaft. These tie-rods and the nuts for straining them may be seen projecting from the outer end of the housing in Fig. 2. By tightening the two sides together in this way, the thrust of the shaft is distributed equally between both sides of the bearing housing. This is a point of great importance in engines of large capacity. The bearing cap has a large central opening extending to the shaft, which is visible while the engine is running.

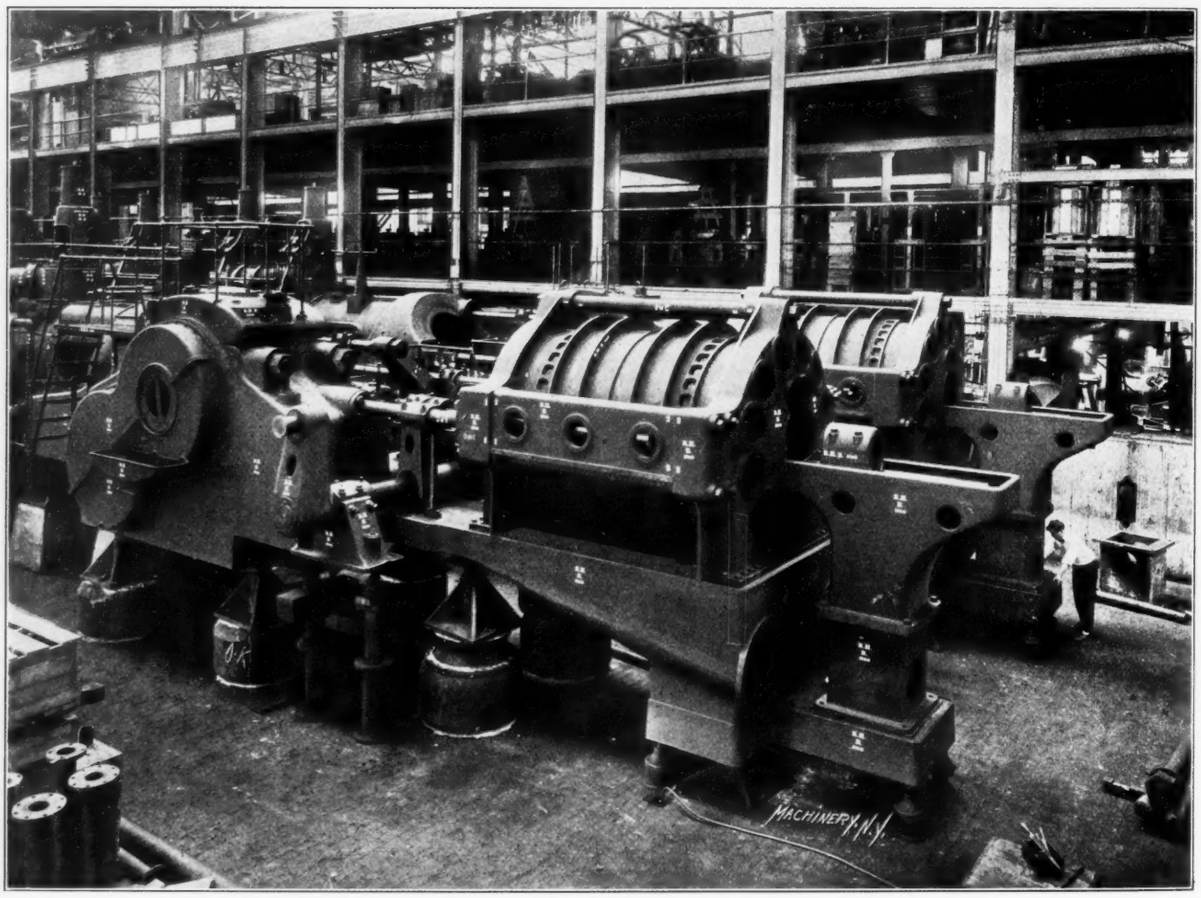


Fig. 2. Another View of the Engines, taken during Erection, showing Blowing Cylinder and Main Bearings.

Cylinders and Housings and the Provision for Expansion.

One of the most serious difficulties met with in the design of gas engines of large size, is that of making provision for the expansion of the structure, resulting from the high heat to which the working parts are subjected. In the case of this engine, only the front housing is fastened to the foundation. The cylinders are supported by the housings at the ends, not resting on the foundation at all; and the center and rear housing are not bolted to the foundations, but are free to slide on them, as the whole structure (fastened only at the other end) expands or contracts with the heating and cooling of the parts.

This high heat also makes necessary great care in the design of the cylinders. They must be of such form that they will expand evenly under the influence of the heating, without warping or twisting in any way. As may be seen in Figs. 6 and 7, they are very nearly symmetrical. In the case of large engines, such as the ones shown herewith, the cylinders are cast in two pieces, as may be seen in Fig. 6. The two halves of the cylinders are held tightly together by the links shown, shrunk into slots in the flanges where the joint between the two halves is made. This makes the two castings practically a solid piece.

The cylinders are, of course, water jacketed. As may be seen in Fig. 6, the jacket walls of the cylinders are cast open at the center, thus avoiding cooling strains in the metal. In Fig. 7, which shows the completed cylinder, the gap between the two jacket castings is covered with the jacket band piece, which is fitted with a water-tight joint, permitting expansion or contraction without the serious strain which would result in so large a cylinder, from the difference in the expansion of the hot inner wall and the cool outer wall of the jacket, if the latter were one solid piece. The removal of this jacket band gives free access to the water spaces for cleaning. Free access is also given to the interior of the cylinder through the large valve opening shown. The valve covers and cylinder heads are also cast hollow for water-jacketing and are provided with suitable openings to facilitate cleaning them thoroughly.

Another variation from steam engine practice made necessary by the great weight of the parts and the high heat to which they are subjected, is the provision made for supporting the pistons from the cross-heads outside of the cylinder, so that no part of their weight bears on the interior surface of the cylinder. The piston of the front cylinder is carried by the main and intermediate cross-heads, while that of the rear cylinder is carried by the intermediate cross-heads and the tail bearings. The pistons are one-piece symmetrical castings, with no sharp corners to induce premature ignition. The rods are packed by water-cooled metallic packings, which receive their oil supply at the center of their length, thus properly distributing the lubrication. The hollow rods serve to feed cooling water to the interior of the piston.

Valves and Valve Mechanism.

The valves are of the poppet type, with inlet valve ports located at the top of the cylinder, and the outlet ports directly opposite, at the bottom. A mezzanine floor below the level of the engine room is provided for inspecting the lower valve gear, easy access being given to all parts of the mechanism, owing to the fact that the cylinders are separated from the housings, leaving a free, open space beneath them.

The valve gear will be best understood by reference to Fig. 8. It is operated from a lay-shaft, driven by bevel and

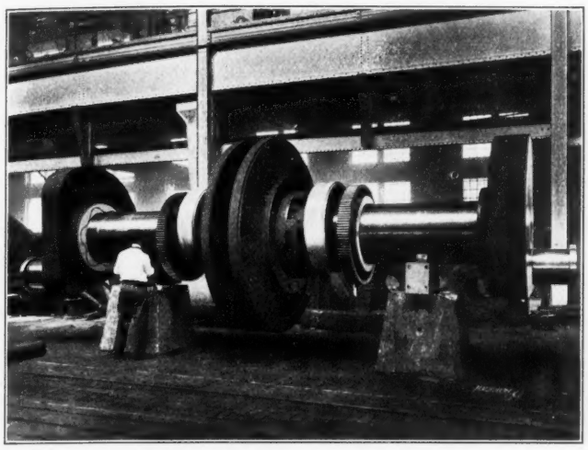


Fig. 3. A Completed Crank-shaft with the Cranks, Spur Gears, Blowing Engine Eccentrics, and Fly-wheel Flanges in Place.

spur gears from the spur gears on the crank-shaft, shown next to the eccentrics in Fig. 3. This use of bevel and spur gears in the place of the usual spiral gears obviates the backlash resulting from the rapid wear of the latter type of gear, and removes the necessity for taking care of the end thrust to which it is subjected. These driving gears have "hunting teeth" to distribute the wear evenly. An eccentric is provided on the long shaft, at each end of each cylinder, the same one serving to operate both the inlet and the outlet valve.

The inlet valves (of the poppet variety, as previously explained), are held up to their seats by helical springs, as shown. The reach rod from the eccentric operates a rocker cam bearing on a lever, which forces the valve open at the proper time, and allows it to return under the influence of the spring when it is time to close it. This valve operating mechanism is an improved form of the well-known gear used on four-valve paddle-wheel engines. It is especially suited for use on gas engines, as it may be arranged to give a great

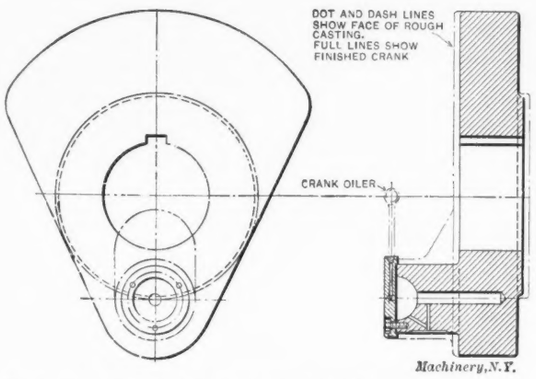


Fig. 4. Detail of Crank and Crank-pin, which form one Solid Piece made from the same Steel Casting.

leverage when first opening a valve, thus relieving the lay-shaft of heavy stress, and of likewise permitting rapid closing of the valves without hammering the seats.

A similar plan is followed in operating the exhaust valves, as may also be seen in Fig. 8. By a careful design of the mechanism, a very wide valve opening has been secured, as has been shown by diagrams taken from the engine while in operation. The rapid and full opening of the valves on the inlet and exhaust strokes materially reduces the velocity of the gases, lessens the resistance to passage through the valves, and considerably increases the capacity of the cylinders.

The exhaust valves are made hollow, and are water-cooled. The cooling water is supplied to the outside portion of the valve, the outlet being by means of a pipe extending through the interior to the top, thus insuring that the valve is always full of water, and preventing the possibility of air pockets. The valve stems of both inlet and exhaust valves are oiled at about the middle of the bearing, thus insuring the lubrication of the whole surface. The valve covers are fitted with a tight joint at their inner ends, thus exposing a minimum surface to the heating action of the products of combustion, and insuring well-cooled valve seats.

Governing Mechanism.

The inlet valve combines the function of inlet, mixing, and governor valves in the single mechanism. A cast-iron sleeve, carried on the valve stem, and free to revolve on it, is provided with two sets of ports, one for gas and one for air, registering with corresponding openings in the valve bonnet in which it fits. This sleeve is revolved on the stem by reach rods from the governor, thus more or less throttling the mixture supplied to the cylinder. It is evident that the sleeve on the valve stem moves up and down, in addition to its rotation under the influence of the governor. This compound movement prevents any possibility of the governor valve sticking when the engine is running under constant load for long periods, during which the governor valve does not change its position.

Another advantage of this arrangement is the fact that the gas and air are mixed at the point where they enter the cylin-

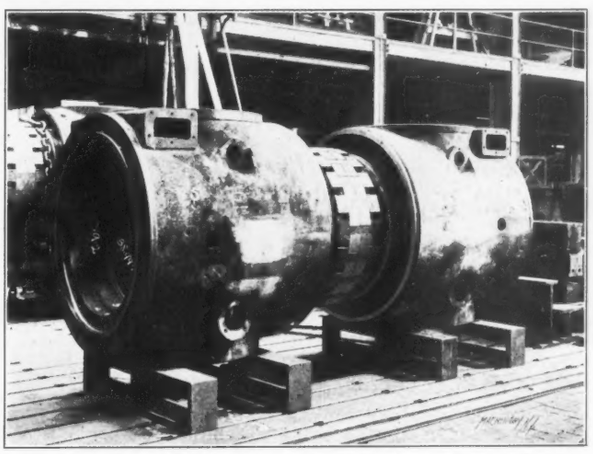


Fig. 5. Partly Finished Cylinder Casting; the Two Halves are shrunk together by the Links shown.

der, as fast as they are needed by the engine, thus avoiding large quantities of idle mixed gases with the resulting difficulty of a large volume of gases exposed to premature ignition. The governor also has the most effective possible control of the engine under these conditions, as the mixture at each end of each cylinder is independently controlled, thus giving far better regulation than can be obtained when the controlling is done at a distance from the inlet ports.

The governor acts on the mixing valves through a relay cylinder, operated by oil pressure. The sole function of the governor is to operate a small pilot valve which controls the movement of the piston in the governing cylinder, which latter is connected by reach rods with the mixing valves on the cylinders of the engine. It is evident, therefore, that the governor is not affected by the movement of the reach rods or by the force required to move them, as it has only to move this small pilot valve. A dash pot is provided on the governor to prevent hunting under variable loads. The governor is driven directly from the main shaft at a point near the front of the machine, where it is unaffected by any slight torsional deflection to which the lay-shaft may be subjected.

In addition to the governor a safety stop is provided, consisting simply of a spring-balanced pin supported in the rim of the fly-wheel, which is forced outward by centrifugal force, if the speed exceeds a predetermined limit. It then

strikes a pawl, which in turn releases a weight attached to a knife switch, which falls and thus opens the igniter circuit, this being the simplest and most positive method of instantly cutting off the power of a gas engine. A safety stop is also provided to automatically open the igniter circuit in case of the failure of the cooling water supply.

Ignition.

The method of ignition used is the result of careful and extensive experiments. The jump spark system was found impractical on all but small engines, operating on rich gas, or

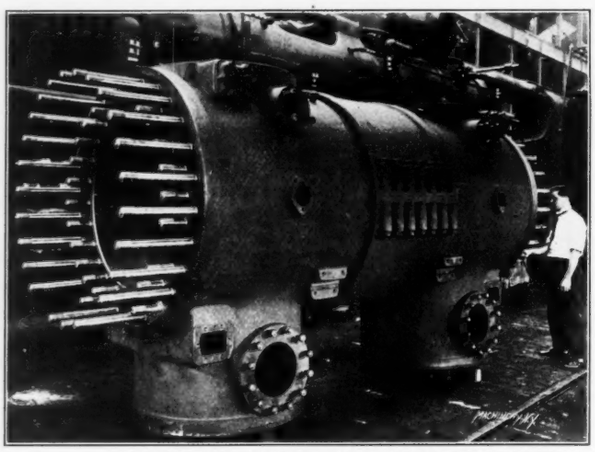


Fig. 6. Completed Cylinder Casting with the Jacket Band in Place.

low compression gasoline gas, because of the fact that the potential required to jump the gap increases directly with the pressure, so that for the high compressions necessary for producer, blast furnace and other "lean" gases, excessive potential is required. The make-and-break system of ignition has therefore been adopted. Each end of each cylinder is provided with three igniters, each with its own independently fused circuit, so that the possibility of a misfire is reduced to a minimum. This gives uniform combustion as well, the charge being lighted at more than one point. The igniter contacts are of cast iron or special bronze which has been found to have remarkable wearing qualities, especially for the low temperature required for ignition by this system. Each igniter circuit is provided with an indicator, which gives visible witness of its operation. Each side of each circuit is separately insulated so that six separate grounds are required to put one end of the cylinder out of commission.

Two forms of ignition gears are employed in the Westinghouse engine, one being mechanically, and the other electrically operated. In either case provision is made for adjusting the time of the ignition. The electrical ignition gear, used on this engine, is operated from a timer or contactor for making and breaking the igniter circuits. In place of the knock-off cams used on the mechanical gear, an electrical knock-off device is used, which is controlled by electrical magnets, operated by the timer mentioned. The advantages of this system are that the ignition is easily advanced and retarded, the same as in the mechanical gear, and that all the igniters at each end of each cylinder are necessarily operated simultaneously. The timer is shown at the right of Fig. 8.

Lubrication.

The engine oil lubrication is effected by a continuous gravity system with filters, insuring ample lubrication of all bearings, crank-pins, cross-heads, etc. All important parts are supplied with right feed oilers. The lubrication of the cylinders is effected by a timed forced lubrication system somewhat similar to, and a development from, that used in automobiles. This system, as applied to the engine, is shown in Fig. 8. Four eccentrics are used, operating valves for each of the two ends of the two cylinders. The oil is supplied at four points in the cylinder, during the suction stroke only. This is a point of great importance, as it gives two working strokes at low temperature, during which all the oil is evenly distributed over the cylinder, thus insuring good lubrication with a minimum supply of oil. The pistons do not touch the cylinders at any point, so that the piston rings form recesses which distribute the oil evenly.

Automatic Starting Machine.

The starting mechanism is automatic, and is operated by compressed air. An air supply pipe, controlled by an unbalanced poppet valve, is fitted to each end of each cylinder, this valve being located directly under an air knock-off cam mounted on the main lay-shaft. To start the engine it is only necessary to turn on the main air valve. This causes the poppet valves to move upward to their seats, one or more of the valves being held down, thus admitting air to the proper cylinders, causing the engines to turn over. As the air is admitted to the cylinder during the power stroke, the exhaust valves permit the escape of the air from the cylinder during the succeeding stroke.

The "Slick Air Tub."

The blower end of this engine is not the least interesting part of the machine. It is of the design known as the "Slick air tub," which has been very successfully used for the handling of air at low and medium pressures. A great point in the mechanical handling of air at low pressures is the provision for ample port area and small clearance. This is effected in the Slick air tub in a way that will be understood from reference to Figs. 2 and 9.

The cylinder heads are stationary and are fastened to the bed, but the cylinder itself slides on the heads, being reciprocated by reach rods from a rock-shaft driven from the air tub eccentric. The eccentrics may be seen between the spur

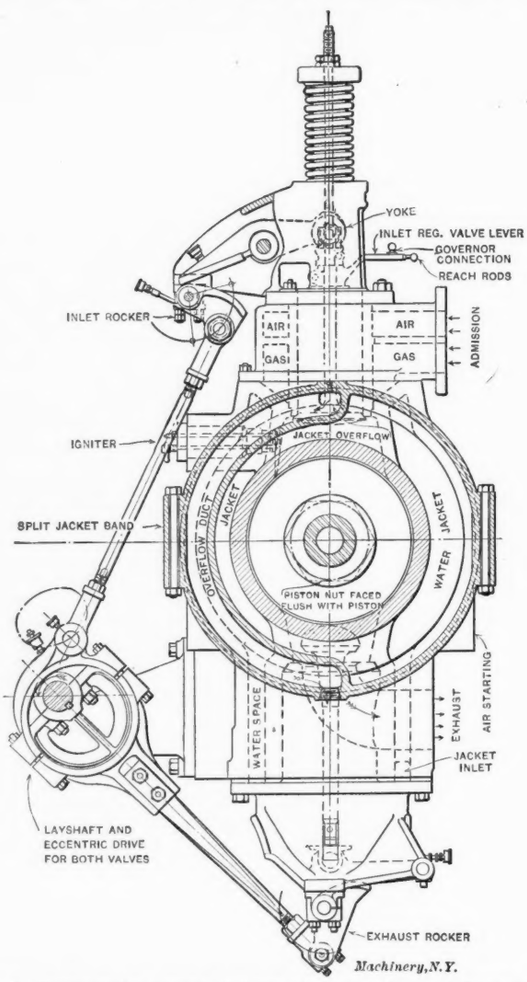


Fig. 7. Cross-section through Cylinder showing Valves and Valve Gear.

gears and the fly-wheel flanges in Fig. 3. The inlet ports are formed around the periphery of the cylinder. As the latter is reciprocated back and forth, with a movement of six or eight inches, these ports are alternately covered and uncovered by the periphery of the cylinder heads. The outlet valves are seated in the cylinder heads. It will be seen that this arrangement gives a minimum clearance, owing to the placing

of the outlet valves in the heads, and the fact that no clearance whatever is required for the inlet ports. The whole area of the heads is available for the outlet valves, while as much of the cylinder periphery as may be necessary can be devoted to the inlet ports.

The parts shown in diagrammatic form in Fig. 9, may be easily followed in the half-tone engraving in Fig. 2. It will

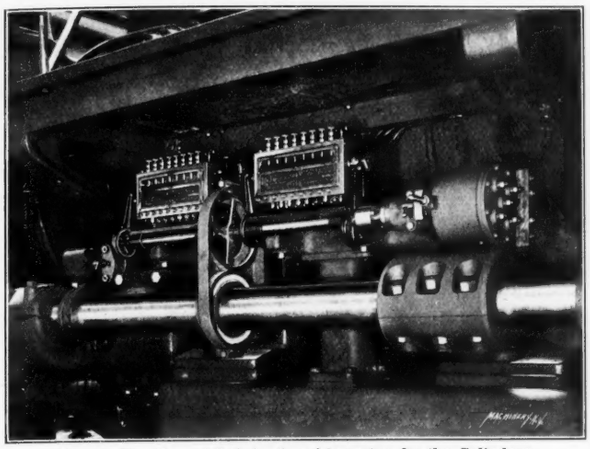


Fig. 8. The Forced Lubricating Apparatus for the Cylinders, and Ignition Timer.

be seen that the piston of the blowing engine cylinder is driven by distance rods from the main cross-head, the crank lying between the cross-head and the blowing cylinder.

The Westinghouse Line of Gas Engines.

The line of gas engines of which the one we have shown is an example, has been designed to be operated without change of design on the wide range of fuels available for the purpose. These fuels include blast furnace gas of 85 to 90 B. T. U. per cubic foot, producer gas from anthracite and bituminous coal, natural gas from the Kansas and Pennsylvania fields, and by-product coke oven gas running as high as 66 per cent hydrogen. All are being successfully employed in the same design of engine.

Various sizes are built, both vertical and horizontal, the former being employed up to 300 H. P., and the latter from there on up to the maximum 3,000 or 4,000 H. P. units. By far the largest number of them are used for driving electric generators, either directly connected or belted, the majority being for alternating current plants. The vertical design has made use of the spring coupling in this service. In horizontal engines, such as that shown in this article, these are unnecessary, except for some particularly difficult high frequency installations. Owing to the system of governing, applied directly to the inlet of each cylinder, a speed regulation as close as 2½ per cent may be obtained.

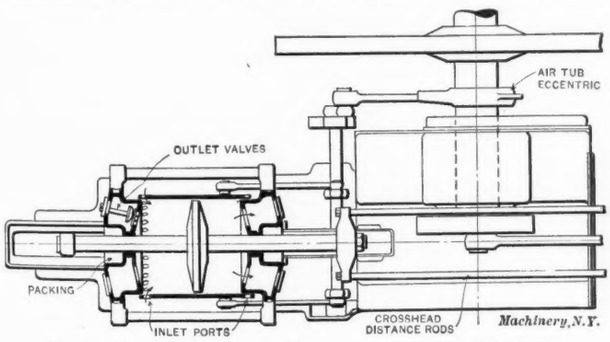


Fig. 9. Diagram showing the Mechanism of the "Slick Air Tub."

Owing to the inherent efficiency of the four-stroke cycle, gas engine economy is largely independent of the size, and a 200 or 300 H. P. vertical engine will give nearly the same efficiency as a large horizontal engine like the one shown. This efficiency ranges close to 10,000 B. T. U. per brake horsepower per hour. The efficiency is largely independent of the kind of gas used, owing to the fact that weaker gases will take a higher compression—almost 200 pounds per square inch, for instance, for furnace gas.

THE DESIGN OF SPRINGS FOR GAS ENGINE VALVES.

F. E. WHITTLESEY.*

Springs for gas engines should be carefully designed, and if properly proportioned for the work they must do, should be just as reliable as any other part of the mechanism. While the general data for spring design are well known to engineers, yet attention may properly be given to some considerations specially applicable to gas engine valve springs. This article will consider compression springs of round steel wire only, as the writer knows of no valid reason for the use of any other material or section for this class of springs. It is well known that square steel is less desirable than round steel for springs, both on account of the higher cost of the springs per pound, and from the standpoint of efficiency.

The first consideration is the selection of the proper values for the fiber stress S and the torsional modulus of elasticity G. Experiments have shown that a fair value for G is 12,500,000, which value is fairly constant for the various grades and tempers of steel within their elastic limits. The safe value for S is not so easily determined, because the correct value for any given class of springs is largely a matter of experience. The highest normal value of S varies from about 120,000 pounds per square inch for 1/16-inch wire, to 90,000 pounds for ⅝-inch wire, which includes the range of sizes generally used on valves. The term "normal value" is used to distinguish these figures from the higher values which can be reached by spring makers, and which are sometimes necessary, but should never be used for rapidly vibrating springs, or for springs where safety and long life are primary considerations, as in this class of springs. In fact, even the above normal values are far too high for gas engine springs. These values are used very generally on machinery springs, etc., but should be reduced very materially to obtain springs which will give the maximum of service in gas engine work. A value of S of from 25,000 to 30,000 pounds per square inch has been found to give best results for gas engine valves.

The third variable is the length of the spring, which should be as long as practicable in order to keep the pressure on the lever or cam which operates the valve from being higher than necessary at the extreme lift of the valve. To illustrate this point we will take a valve on which a pressure of 40 pounds when closed is desired, and which opens ½ inch. If the spring is under ½ inch compression when the valve is closed, and holding 40 pounds, the pressure when the valve is open will be 80 pounds. But if we use a spring under 1¼ inch compression to hold 40 pounds when the valve is closed, when the valve is opened the ½-inch travel, the pressure will be increased to only 56 pounds. The diameter and assembled length of the spring will usually be determined by the general design of the engine. The diameter should be as large as convenient, which will lessen the tendency to buckle.

We will now design a spring for an exhaust valve, the lift of the valve being ½ inch, the assembled length of the spring 6 inches, the pitch diameter of the spring 2 inches, and the value of S at extreme compression 25,000 pounds per square inch. We will make the spring 7¼ inches long, thus giving a total compression of 1¾ inch, and a final pressure of 56 pounds. The following formulas will be used:

$$P = \frac{11d^3S}{28D} \quad \ldots(1) \qquad f_1 = \frac{22D^2S}{7Gd} \quad \ldots(2)$$

P = pressure at given compression,
d = diameter of wire in inches,
D = pitch diameter of spring in inches,
f_1 = deflection of one coil in inches,
S = fiber stress in pounds per square inch,
G = torsional modulus of elasticity.

[The common form of the formulas (1) and (2) is

$$P = \frac{8\pi d^3}{16R} \quad \ldots(3) \qquad f = \frac{32PR^2l}{G\pi d^4} \quad \ldots(4)$$

In these formulas P, d, S, and G, denote the same quantities as in formulas (1) and (2), and

* Address: Care Raymond Mfg. Co., Corry, Pa.

R = pitch radius of spring in inches,
f = deflection of the whole spring under load,
l = full length of wire in spring.

The formulas (3) and (4) can easily be transformed to the form in (1) and (2) by writing $\pi = 22/7$, $R = D/2$, and $l = \pi Dn$ (n being the number of coils in the spring).—EDITOR.]

We use formula (1) to determine the size of the wire. Substituting the known values, we have

$$56 = \frac{11d^3 \times 25{,}000}{28 \times 2}, \text{ or } d = 0.225.$$

We therefore will use No. 4 Washburn & Moen gage wire, which is 0.225. To determine the deflection per coil, we will substitute the known values in formula (2), as follows:

$$f_1 = \frac{22 \times 4 \times 25{,}000}{7 \times 12{,}500{,}000 \times 0.225} = 0.112 \text{ inch.}$$

The free length of the spring is 7¼ inches, and the length with the valve open is 5½ inches, the compression therefore is 1¾ inch. Then 1¾ ÷ 0.112 (the compression per coil) gives 15¾ acting coils approximately, and adding one coil on each end, for a flat bearing to be ground at right angles to the axis of the spring, gives 17¾ total coils. Therefore the spring will be 2-inch pitch diameter, 7¼-inch free length, No. 4 W. & M. gage wire, 17¾ total coils, squared and ground ends, holding 40 pounds at 6 inches long, and 56 pounds at 5½ inches long, with a fiber stress at 5½ inches long of 25,000 pounds per square inch.

If it is desirable that the pressure, when the valve is open, rise *as little as possible* above 40 pounds, we must make the spring as long as possible and still compress to the closed length given. We will assume a spring 2 inches pitch diameter, to hold 40 pounds when 6 inches long, and as little over 40 pounds as possible at 5½ inches long. As we do not know the pressure at 5½ inches long, we will take the fiber stress 25,000 pounds at 6 inches long, instead of at total compression.

Using formula (1): $40 = \frac{11d^3 \times 25{,}000}{28 \times 2}$, or $d^3 = \frac{224}{27{,}500}$, and $d = 0.200$.

We will therefore use No. 5 W. & M. gage wire, which is 0.207.

Using formula (2): $f_1 = \frac{22 \times 4 \times 25{,}000}{7 \times 12{,}500{,}000 \times 0.207.} = 0.1215$ inch

compression per coil when holding 40 pounds. Then 5½ inch solid length less twice 0.207 gives the length occupied by the acting coils when solid, or 5.086 inches, and 5.086 ÷ 0.207 = 24.5 acting coils. Further, 24.5 × 0.1215 = 2.975 inches compression, which added to 6 inches gives 8.975 inches free length of the spring, say 9 inches. The spring therefore compresses 3 inches when holding 40 pounds, with a value of S of 25,000 pounds and at 5½ inches long, being compressed 3½ inches, holds 46 2/3 pounds, with a value of S of $\frac{46\ 2/3}{40} \times$ 25,000 or 29,166 2/3 pounds.

In these examples we have not corrected the values of S to allow for the variation in sizes of wire used, from the theoretical sizes obtained, as it is not necessary to do so in practice. It is interesting to note, however, the difference in this value at final compression, obtained by the above method of proportion based on 25,000 pounds at 40 pounds pressure, from that obtained by using the original formula with the final pressure of 46 2/3 pounds, and wire of 0.207 inch diameter. The first method gives 29,166 pounds, while the second method gives 26,782 pounds, this difference being caused by the difference of 0.007 in the size of wire.

* * *

The growing practice of casting threaded holes in machine details is referred to by the *Engineering Record*. Wrought iron nuts are inserted in the molds and properly located, being held securely by projections from the cores. For work which does not necessitate any high degree of accuracy, the nuts can be placed in the casting close enough for the purpose required. This obviates the necessity of drilling and tapping operations at the same time, as wrought iron threads have greater strength than the threads cut in the cast iron itself.

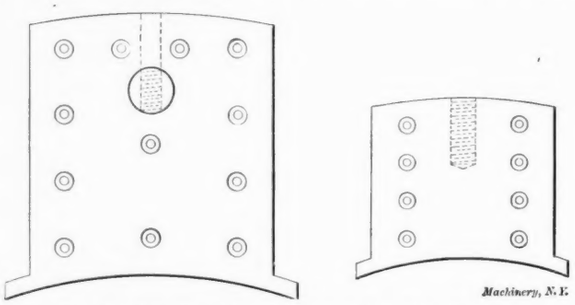
POLE PIECE DESIGN FOR DYNAMOS.*

E. A. LÖF.†

To give a definite rule for the design of pole pieces is almost impossible, due to the many different shapes of poles used by the various dynamo manufacturers. The parts of which a pole piece consists are the punchings, the end-plates, the rivets, and the bolts holding the pole piece to the frame. Each of these parts will in the following treatise be treated separately, and some data and dimensions will be given, illustrating the present practice of their design.

Punchings.

The punchings are made up of soft sheet steel, carefully annealed, and of a size of about No. 16 U. S. gage. Before assembling, each punching should be thoroughly lacquered with an approved insulating varnish, and then left to dry. For determining the number of punchings required for a pole piece of a certain width, it may be said that the lacquer occupies about 5 per cent of the total width. The punchings are pressed together in a hydraulic press. The shapes of the punchings vary greatly, dependent upon the electrical design.



Figs. 1 and 2. Examples of Types of Pole Piece Design.

Figs. 1, 2, and 3 show a few of the various forms of punchings used. Some manufacturers have one of the face-corners of each punching cut off, and the laminations are laid with the beveled corners alternately to one side and then the other, thus producing a pole piece with saturated tip.

End-plates.

To give the pole piece a more substantial construction, an end-plate of heavier thickness is provided for each end. These end-plates are made up of tank steel, and are of the same form as the punchings. The edges are either straight or rounded. If straight, they should be chamfered at 45 degrees, and if rounded, the radius should be equal to the thickness of the plate, as shown in Figs. 4 and 5. The thickness of the plate is determined by the size of the rivets holding the pole pieces together. Table I gives suitable thicknesses based upon standard rivet diameters.

TABLE I.

Rivet diameter	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	3/4
End-plate	1/4	1/4	3/8	3/8	1/2	1/2	5/8	5/8	3/4

Rivets.

Some methods of distributing the rivets are shown in Figs. 1, 2, and 3. This distribution, however, is entirely dependent upon the shape and size of the pole piece. If there is not sufficient space for a standard size rivet, a greater number of smaller diameter rivets should be used. Rivets should not be placed too close to the edges. The distance from the rivet to the edge should never be less than the diameter of the rivet. If less, the end-plate is liable to break.

TABLE II.

Building-up pressure in tons	10	15	20	25	35	40	60
Rivet diameter	5/16	3/8	7/16	1/2	9/16	5/8	3/4

The building-up pressure required for a pole piece is usually a reasonable guide for determining the rivet diameters. Table II gives dimensions of rivet diameters such that the building-up pressure will head-up the rivets cold in pairs.

* See MACHINERY, January, 1907: Mechanical Calculations and Data for Dynamo Design.

† Address: 2121 W. Monroe St., Chicago Ill.

When the building-up pressure is 60 tons and over, ¾-inch rivets should be used, if there is sufficient space for them. Larger size of rivets than ¾ inch should not be used.

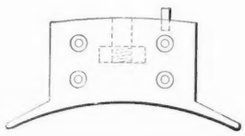
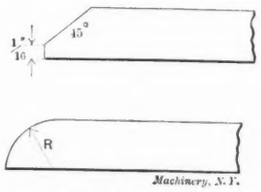


Fig. 3. A Third Type of Pole Piece Design.



Figs. 4 and 5. Design of Edge of End-plates.

For determining the number of rivets required, it has been found from actual practice that as an average for every square inch of rivet there is about 40 square inches of punching area. Thus,

Approximate number of rivets =

$$\frac{\text{Area of punching in square inches}}{40 \times \text{area of one rivet}}$$

Table III gives for each rivet diameter the area of the rivet, and a suitable pitch that will allow 40 square inches punching area for each square inch of rivet cross-section. It also gives the distances from the center of the rivets to the edge of the end-plate.

TABLE III.

Diameter of rivet	¼	5/16	⅜	7/16	½	9/16	⅝	¾
Area	.049	.077	.110	.150	.196	.249	.307	.442
Pitch	1⅜	1¾	2⅛	2 1/2	2⅜	3⅛	3½	4¼
Distance to edge	¾	⅞	1	1 1/4	1⅜	1½	1¾	2⅛

As mentioned before, the spacing of the rivets is, to a great extent, dependent upon the size and shape of the pole pieces, and good judgment must be relied upon to adjust the diameters and pitch so as to suit each particular case. The rivets may be either of the cold rolled steel tight-fit type or of the wrought iron clearance type.

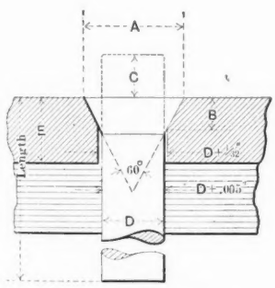


Fig. 6. Tight-fit Rivets.

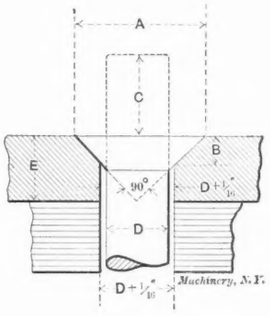


Fig. 7. Clearance Rivets.

Cold Rolled Steel Tight-fit Rivets.

For this type of rivets the holes in the punchings should be 0.005 inch larger than the rivet diameters. This will produce a tight fit when assembled. The holes in the end-plates should be 1/32 inch larger than the rivets. The riveting is done cold in the press; only the final peening of the head is done by hand. Tight-fit rivets are used in all bolted-in pole pieces. Fig. 6 and Table IV give dimensions for a standard line of tight-fit rivets.

TABLE IV. TIGHT-FIT RIVETS.

(See Fig. 6 for notations.)

Rivet Diameter D.	A	B	C	E
¼	3/8	1/8	3/16	1/4
5/16	1/2	5/32	1/4	5/16
⅜	5/8	3/16	1/4	3/8
7/16	3/4	1/4	1/4	1/2
½	13/16	9/32	5/16	1/2
9/16	15/16	5/16	3/8	5/8
⅝	1	5/16	7/16	5/8
¾	1 3/16	3/8	9/16	3/4

Wrought Iron Clearance Rivets.

The rivet holes in the punchings and the end-plates for this type of rivets are made 1/16 inch larger than the rivets.

TABLE V. CLEARANCE RIVETS.

(See Fig. 7 for notations.)

Rivet Diameter D.	A	B	C	E
¼	1/2	1/8	5/16	1/4
5/16	5/8	1/8	3/8	3/8
⅜	3/4	1/8	1/2	1/2
7/16	7/8	3/16	9/16	1/2
½	1	3/16	5/8	5/8
9/16	1 1/8	1/4	11/16	5/8
⅝	1 1/4	1/4	¾	¾
¾	1 1/2	5/16	¾	¾

All riveting is done hot. Clearance rivets are used in all cast-in pole pieces. Fig. 7 and Table V give dimensions for a line of clearance rivets.

Bolts.

The pole pieces are secured to machined surfaces inside the frame by one or two bolts for each pole piece. These bolts pass through the frame into the pole piece. They do not, however, pass entirely through the poles, but leave the pole faces smooth and unbroken. For smaller pole pieces the treading is done directly in the punchings, but for larger sizes it is advisable to provide a large solid iron cross bar passing lengthwise through the pole piece. This bar in then drilled and threaded for the bolts. The former practice is shown in Fig. 2 and the latter in Fig. 1. The method of fastening the pole pieces by means of bolts permits the removal of the poles and the field coils without separating the frame, and repairs can be made in the shortest possible time. If only one bolt is used for holding the pole piece in place, it is advisable to provide a dowel pin to prevent the pole piece from turning.

In Figs. 8 and 9 are shown two kinds of bolts. The one shown in Fig. 8 is mostly used for rotating field pole pieces. Fig. 9 shows a machine bolt tapped into the pole punchings.

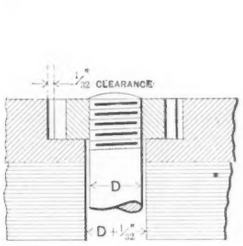


Fig. 8. Steel Bolt for Rotating Field Pole Pieces.

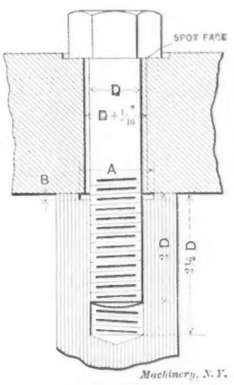


Fig. 9. Machine Bolt tapped into Pole Punchings.

Referring to the reference letters in Fig. 9, if D is less than 1⅜ inch, then $A = D + ¼$ inch, and $B = ⅛$ inch. If D is larger than 1⅜ inch, then $A = D + ⅜$ inch, and $B = 3/16$ inch. The diameter D of the bolts can be calculated from formulas as given in any mechanical handbook.

* * *

A new employers' liability bill, intended to meet the objections found by the Supreme Court of the United States, in declaring the previous bill passed unconstitutional, was passed by the House of Representatives at Washington on April 6. On April 9 the bill was also passed by the Senate. This law is specifically directed towards railroads engaged in interstate commerce, and will hold railroad companies liable for all injuries to employes while engaged in commerce between the states or territories, and also when engaged in commerce wholly within a territory. The bill passed in the House by a vote of 300 to 1, but it is feared that the present bill may not stand the test of constitutionality when subjected to the test of the Supreme Court.

COMPARATIVE VALUE OF ALCOHOL AND GASOLINE AS ENGINE FUELS.

The technologic branch of the United States Geological Survey, under the direction of Mr. J. A. Holmes, has recently completed an elaborate series of tests on the relative value of gasoline and alcohol as producers of power. The tests, over two thousand in number, probably represent the most complete and exact investigation of the kind that has been made either in this country or abroad, and includes much original research work.

Professor R. R. Fernald, engineer-in-charge of the gas producer section and professor of mechanical engineering in the Case School of Applied Science, Cleveland, Ohio, was in general charge of the tests. R. M. Strong, formerly connected with the engineering department of Columbia University, had personal supervision of the work. He was assisted by a corps of specially-trained men.

These tests were conducted at the fuel testing plant of the Geological Survey at Norfolk, Va., and show the following results in regard to the comparative fuel consumption of 73 degrees specific gravity gasoline and commercial completely denatured alcohol, per unit of power.

Correspondingly well-designed alcohol and gasoline engines when running under the most advantageous conditions for each, *will consume equal volumes* of the fuel for which they are designed. This statement is based on the results of many tests made under the most favorable practical conditions that could be obtained for the size and type of engines and fuel used. An average of the minimum fuel consumption values thus obtained, gives a like figure of eight-tenths pint per hour per brake-horse-power for gasoline and alcohol.

Considering that the heat value of a gallon of denatured alcohol is only a little over six-tenths that of a gallon of gasoline, this result of equal fuel consumption by volume for gasoline and alcohol engines probably represents the best comparative value that can be obtained for alcohol at the present time, as is also indicated by Continental practice. Though the possibility of obtaining this condition in practice here has been thoroughly demonstrated at the Government fuel-testing plant, it yet remains with the engine manufacturers to make the "equal fuel consumption by volume" a commercial basis of comparison.

The gasoline engines that were used in these tests are representative of the standard American stationary engine types, rating at 10 to 15 horse-power, at speeds of from 250 to 300 revolutions per minute, while the alcohol engines were of similar construction and identical in size with the gasoline engines.

The air was not preheated for the above tests on alcohol and gasoline, and the engines were equipped with the ordinary types of constant level suction lift and constant level pressure spray carbureters. Many special tests with air preheated to various temperatures up to 250 degrees F., and tests with special carbureters were made, but no beneficial effects traceable to better carburation were found when the engines were handled under the special test conditions, including constant speed and best load.

The commercial completely denatured alcohol referred to is 100 parts ethyl alcohol plus 10 parts methyl alcohol plus ½ part benzol, and corresponds very closely to 94 per cent by volume or 91 per cent by weight ethyl alcohol (grain alcohol). No detrimental effects on the cylinder walls and valves of the engines were found from the use of the above denatured alcohol.

The lowest consumption values were obtained with the highest compression that it was found practical to use; which compression for the denatured alcohol ranged from 150 to 180 pounds per square inch above atmosphere.

Eighty per cent alcohol (alcohol and water) for use in engines of the present type would have to sell for at least 15 per cent less per gallon than the denatured alcohol in order to compete with it. The minimum consumption values in gallons per hour per brake-horse-power for 80 per cent alcohol is approximately 17.5 per cent greater than for the denatured alcohol used, or for gasoline. A series of tests made with alcohol of various percentages by volume, ranging from 94 per cent to 50 per cent showed that the minimum consumption values in gallons per hour per brake-horse-power increased a little more rapidly than the alcohol decreased in percentage of pure alcohol. That is, the thermal efficiency decreased with the decrease in percentage of pure alcohol. This decrease in thermal efficiency or increase in consumption, referred to pure alcohol is, however, comparatively slight from 100 per cent alcohol down to about 80 per cent alcohol. Within these limits it may be neglected in making the calculations necessary to compare the minimum consumption values for tests with different percentages of alcohol.

The nearer the alcohol is to pure, the greater the maximum horse-power of the engine. The per cent reduction in maximum horse-power for 80 per cent alcohol as compared with that for denatured alcohol used was less than 1 per cent, but the starting and regulating difficulties are appreciably increased.

With suitable compression, mixtures of gasoline and alcohol vapors (double carbureters) gave thermal efficiencies ranging between that for gasoline (maximum 22.2 per cent) and that for alcohol (maximum 34.6 per cent) but in no case were they higher than that for alcohol. The above thermal efficiencies are calculated from the brake-horse-power and the low calorific value of the fuel, which for the gasoline was 19,100 British thermal units per pound and for the denatured alcohol was 10,500 British thermal units per pound.

As has been previously demonstrated, alcohol can be used with more or less satisfaction in stationary and marine gasoline engines, and these gasoline engines will use from one-and-one-half to two times as much alcohol as gasoline, when operating under the same conditions. The possibilities, however, of altering the ordinary gasoline engine as required to obtain the best economies with alcohol are very limited; for the amount that the compression can be raised without entirely redesigning the cylinder heads and valve arrangement is ordinarily not sufficient, nor are the gasoline engines usually built heavy enough to stand the maximum explosive pressures, which often reach 600 and 700 pounds per square inch. With the increase in weight for the same sized engine designed to use alcohol instead of gasoline, comes an increase in maximum horse-power of a little over thirty-five per cent, so that its weight per horse-power need not be greater than that of the gasoline engine, and probably will be less.

The work was taken up to investigate the characteristic action of fuels used in internal combustion engines with a detailed study of the action of each fuel (gasoline and alcohol) as governed by the many variable conditions of engine manipulation, design and equipment. These variables were isolated, so far as possible; their separate and combined effects were determined; worked out under practical operating conditions; and lead up to the conditions required for minimum fuel consumption. The results show the saving that can be obtained over conditions for maximum consumption, and also establish a definite basis of comparison under conditions most favorable to each fuel. This latter is a point of much commercial interest and a study of the comparative action of gasoline and alcohol may be of great service in solving some of the general internal combustion engine problems where other than liquid fuels are used.

Many of the tests of internal combustion engines have been made, but most of them, especially in this country, were by private concerns, for a specified purpose, and the results are not generally available. Furthermore, as is generally recognized by those familiar with gas and especially gasoline engine operation, the conditions influencing engine performance are so numerous and varied as to make the value of off-hand comparison very limited and oftentimes misleading, exact comparisons only being possible under identical conditions or with reference to the actual known differences in all conditions that influence the results.

This investigation was made with a view to supplying the continually increasing demand for more complete and exact information concerning the operation and design of gasoline and alcohol engines and to assist the Government and others interested in the larger and more general internal combustion engine problems.

GEAR-CUTTING MACHINERY—5.

RALPH E. FLANDERS.*

This installment of this series of articles on gear-cutting machinery, continues the discussion of machines for cutting the teeth of worms, and of spiral and herring-bone gears, begun in the last issue.

Automatic Machines for Milling Helical Gears with Formed Cutters.

A number of full automatic machines have been built in an experimental way for milling spiral gears with formed cutters. They have usually been modelled after the automatic spur gear cutter. Evidently the mechanism has to be considerably more complicated. The first complication involved is due to the fact that the index wheel must be under the influence of both the helical and the indexing movements, as in the Reinecker machine in Figs. 85 and 86. The differential gearing there shown is the arrangement generally used to effect the combination of these movements in the automatic helical gear-cutter.

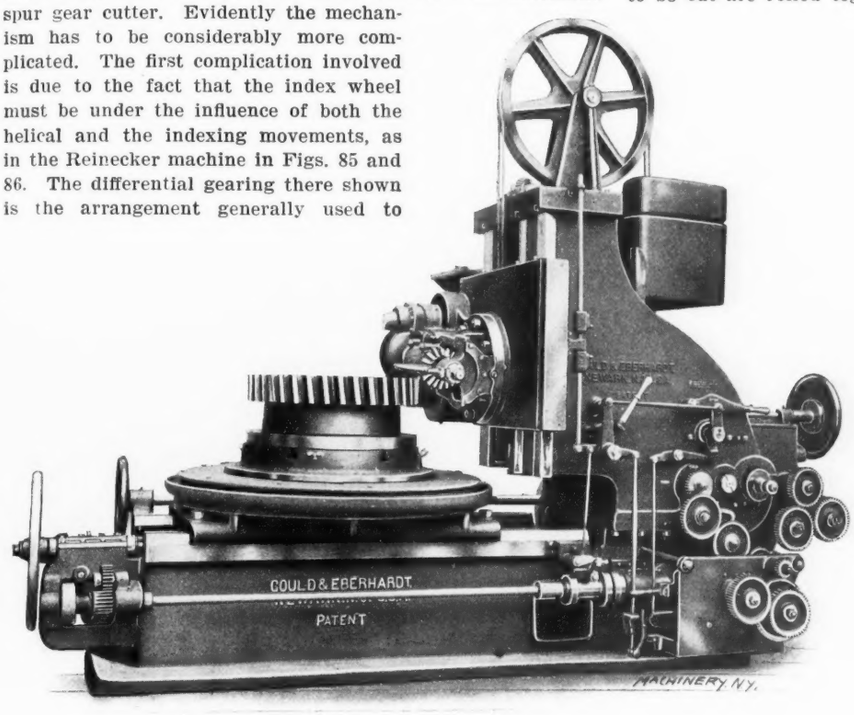


Fig. 91. Automatic Helical Gear-cutting Machine, made by Gould & Eberhardt.

Another complication is introduced by the necessity for relieving the cutter on its return stroke, after finishing the forward feed through the blank. Backlash in the rotating mechanism between the cutter slide and the work so alters the position of the cutter and the work on the return stroke, that the latter will drag on the one side of the groove it has just cut, unless it is separated slightly from it. This has been done in various ways in the various machines built; in some cases by mounting the cutter on a supplementary holder which rocks back out of the way on the return stroke, and in other cases by withdrawing the work by mechanism provided for the purpose.

These various complications seem to have militated against the commercial success of the automatic spiral gear cutting machine to such an extent that, so far as we know, but one of the various designs built has ever left the shop where it was made. The design we refer to is that shown in Fig. 91, built by Gould & Eberhardt of Newark, N. J. As will be seen, it is a machine of large capacity, built in the form of the horizontal machines for cutting spur gears, shown in Figs. 29 to 36. The cutter spindle is, of course, set in a swiveling head, and is driven by worm gearing. Three sets of change gears are used—one of them for the indexing mechanism, one for obtaining the proper lead of the helix, and one for changing the feed. The relieving mechanism operates as follows: As the cutter is being rapidly returned to allow the work to be indexed for a new cut, the work is withdrawn slightly from contact with the cutter by a cam actuated device, connected with the indexing mechanism. On the conclusion of the indexing, the work is again brought up to the cutting position, and the cutter is fed downward for a new tooth.

* Associate Editor of MACHINERY.

Molding-Generating Principle for Cutting Helical Gears—Planing Operations.

Passing by the templet, odontographic, and describing-generating principles, for the reasons mentioned in the introduction to this section (page 511), we come to the molding-generating principle. This is applied to helical gears in the same way as to spur gears, with such modifications as are necessary to allow for the helical shape of the teeth. The counterpart of Fig. 6 is shown in Fig. 92. The forming cutter and the blank to be cut are rolled together as in Fig. 6, while the forming cutter is reciprocated axially. In combination with the axial movement, however, the cutter has to be given a rocking movement about its center line, so that its teeth will follow the path of the dotted lines shown, which indicate the helix of the spiral gear which the cutter represents.

This process was contemplated by Mr. Fellows, of the Fellows Gear Shaper Co., in the original working out of his system of gear-cutting. Given suitable cutters, the necessary changes in the machine shown in Fig. 63, would simply be those involved in giving the cutter a rotary rocking motion in unison with its reciprocating movement, to compel the tooth to follow the line of the helix of the gear which the cutter represents. It is not probable that this process will ever come into commercial use, as the great number of helix angles required would involve too large a stock of cutters.

The counterpart of Fig. 7, for helical gears, is shown in Fig. 93. Here the forming rack has teeth set on the same angle as the helix angle desired in the gear being formed. The rolling of a plastic blank over this forming rack will form in the blank helical teeth of the shape desired. A top view of the rack is shown, which will make this clearer. Instead of the forming rack shown by the full lines, we may use one like that shown in the dotted lines, whose teeth coincide with

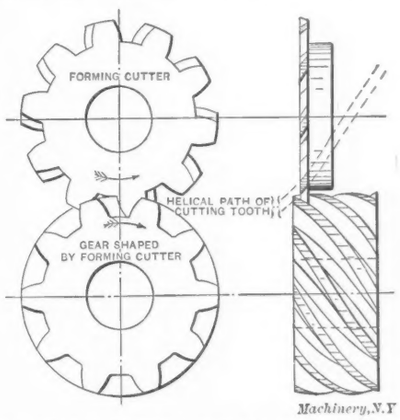
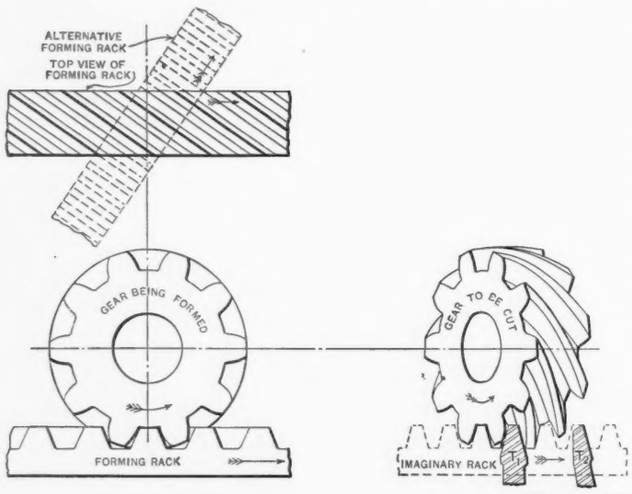


Fig. 92. The Molding-Generating Principle arranged to employ a Cutter having a Helical Shaping Action, cutting Teeth in a Solid Blank; compare with Fig. 6.

those of the first, but which moves in a direction at right angles to the direction of its teeth. If this dotted rack is moved at such a rate of speed that its teeth always coincide with those of the rack shown in full lines, they will evidently both form teeth of exactly the same shape in the blank.

In Fig. 94 we have the dotted rack of the top view of Fig. 93, shown engaged in the operation of generating the teeth of a

gear identical with that in Fig. 93. This view has been taken at an angle so as to show the normal view of the rack. If the proper relative rates of rotation of the work and movement of the rack are maintained in Figs. 93 and 94, and the normal sections of the racks in each case are the same, the gears generated will be the same. It is evident in Fig. 94 that the teeth of the rack may be replaced by shaper or planer tools T_1 and T_2, which may be used in forming teeth on the blank



Machinery, N.Y.

Fig. 93. A Rack with Teeth set on an Angle, Operating by Impression on the Molding-Generating Principle, to form Teeth in a Helical Gear; compare with Fig. 7.

Fig. 94. Shaper Tools representing Teeth of Imaginary Rack, Operating on the Molding-Generating Principle to generate Teeth in a Helical Gear; compare with Fig. 8.

by rotating the gear and moving the tools endwise, in the proper ratio prescribed by the conditions in Fig. 93. Fig. 94 is thus the counterpart of Fig. 8 for helical gearing. Similar counterparts may be drawn for Figs. 9 and 10, showing the milling and grinding processes, but since no practical application is made of these, they are omitted.

Fig. 94 is interesting in that it hints at the principle on which the action of the helical gearing is based. As drawn, it shows very plainly the action of the well-known Sellers drive for planers. It will be noted that for a short space the rack teeth exactly fill the outline of the gear tooth. Contact between the gear and the rack takes place on straight lines, running diagonally across the plane faces of the rack teeth. Much might be written about the contact between spiral gears and racks, and the contact of spiral gears with each other, that has not been published, so far as the writer is aware; but since this subject is not germane to the subject of this series of articles, it will not be touched on here.

Practical application has been made of the principle shown in Fig. 94. The Bilgram spiral gear planing machine, involving this principle, is shown in Fig. 95. The work is mounted on a spindle carried in a head, which swivels about a vertical axis so that it may be set to the helix angle of the gear being cut. The cutting tool, having a shape to represent a tooth of the imaginary generating rack, is carried by a ram which works in and out, cutting on the return stroke. This ram is carried by a head which is fed along the bed of the machine. This longitudinal feeding of the ram-carrying head is connected with the rotary movement of the work spindle by change gearing, in the proper ratio for the case in hand, so that the gear will roll with the movement of the head just as it would if it were acting under the influence of the imaginary rack, one of whose teeth is represented by the cutting tool. The conditions are thus exactly the same as in Fig. 94.

Under these conditions, if the machine is set properly, the cutting tool will start to work at one side of the blank, and pass through it, feeding at the end of each successive stroke, with the work rolling in such a way as to form a tooth space of the proper shape. This action is modified somewhat by the method of indexing adopted, which is the same as for the somewhat similar spur gear planing machine by the same builder, shown in Fig. 48. The arrangement used indexes the work at every stroke, so that when the tool has once passed through the work, the gear is entirely completed, every tooth having been worked on. This indexing movement and the rolling motion required for the generating are superimposed on each other by suitable mechanism so that neither interferes with the other.

It may be mentioned incidentally that this machine is the only one known to the writer in which *all* the requirements for theoretical accuracy in cutting helical gears have been taken care of. There is a minute, though actual, error involved in even the otherwise perfect hobbing process for cutting these gears.

The Hobbing Modification of the Molding-Generating Principle of Cutting Helical Gears.

Instead of using the shaper or planer tool to take the place of the teeth of the imaginary rack shown in Fig. 94, we may use a hob, in the same way that it was used in Fig. 50 for hobbing spur gears. This condition is shown in Fig. 96, which should be compared with Figs. 50 and 94. The upper or plan view best shows the respective angular settings of the work and the hob. The hob is set at an angle with the line of movement of the imaginary rack equal to its own helix angle, as for spur gears. The gear being cut is set at an angle with this same line equal to its own helix angle, so that in this case (in which both gear and hob are right-hand) they are set at an angle to each other equal to the difference between the helix angles. If the hob represented by the worm in the diagram is revolved in the direction shown, its teeth will have the same outline and the same movement as the teeth of an imaginary rack, moving in the direction shown. If the work be revolved in the proper ratio with the hob, the latter will form the teeth in the former in the same way that the imaginary rack would, provided it is fed progressively through the work in the direction of line $X\ X$.

This necessity for feeding the hob through the work introduces an added complexity to the machine in the case of

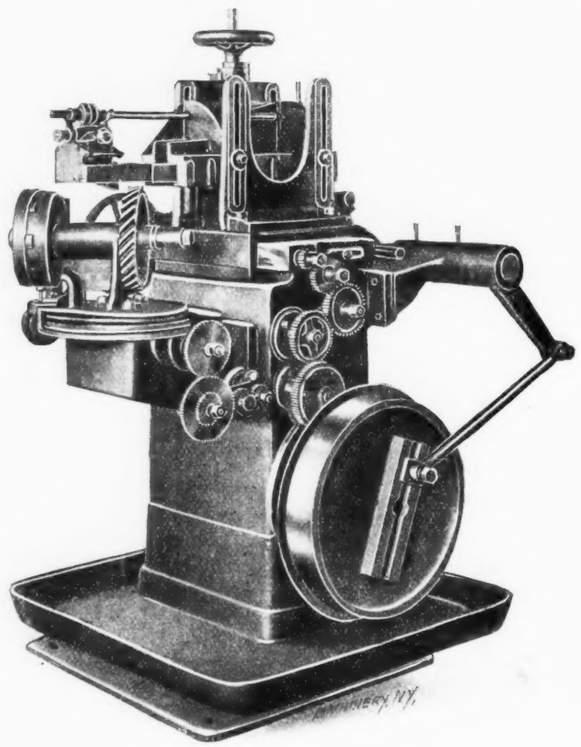


Fig. 95. The Bilgram Machine for Cutting Helical Gears, operating on the Principle of Fig. 94.

spiral gears, beyond that needed for the spur gear hobbing machine. To understand this, suppose that in Fig. 96 the spindle mechanism is stopped, so that both the spindle and work ceased to revolve. To make it possible to feed the hob through the work in the direction of line $X\ X$ without having the teeth of the one strike against the other, it will be necessary to revolve either the work or the hob. Suppose that the work be connected by change gearing with the feed-

screw of the cutter slide, so that it is revolved as the cutter is fed up or down, in the same way that the work in Fig. 81 is revolved as the table is fed backward and forward. Under these conditions, the cutter may be moved through the work freely, the latter revolving to allow the cutter to pass. Not only must the work revolve in a definite relation with

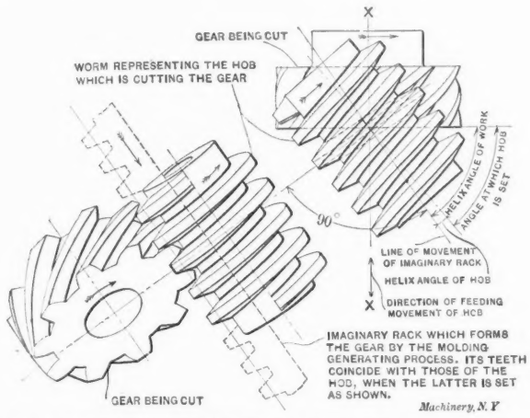

X
GEAR BEING CUT
WORM REPRESENTING THE HOB WHICH IS CUTTING THE GEAR
HELIX ANGLE OF WORK
ANGLE AT WHICH HOB IS SET
90°
LINE OF MOVEMENT OF IMAGINARY RACK
HELIX ANGLE OF HOB
X
DIRECTION OF FEEDING MOVEMENT OF HOB
IMAGINARY RACK WHICH FORMS THE GEAR BY THE MOLDING-GENERATING PROCESS. ITS TEETH COINCIDE WITH THOSE OF THE HOB, WHEN THE LATTER IS SET AS SHOWN.
GEAR BEING CUT
Machinery, N.Y.

Fig. 96. Molding-Generating Method of Cutting Spiral Gears, as Exemplified in the Hobbing Process; compare with Figs. 50 and 94.

the feeding of the cutter slide, but the work must also revolve in unison with the cutter or hob, as for spur gears. It must then be so connected with the cutter and with the cutter slide feed-screw that it will be under the influence of either or both of them, without any interference of the two movements with each other. This connection is usually made by a "jack-in-the-box" or differential mechanism, exactly identical in principle with that shown in Fig. 86 for combining the indexing and helical feeding movements for revolving the work in the Reinecker universal machine. In the case of the spiral gear hobbing machine we have a helical feeding movement and a cutter spindle movement to combine for revolving the work.

A typical arrangement of the mechanism used for this purpose is shown in diagrammatic form in Fig. 97. Power is applied to the machine through driving shaft *G*. The bevel gears shown connect this driving shaft with vertical shaft *H*, by means of which the hob is driven. Change gears shown connect shaft *G* with shaft *E*. Considering for the time being that worm-wheel *B* and the attached bevel gear *D* are stationary, the rotation of *E* and the cross arm *A* keyed to it,

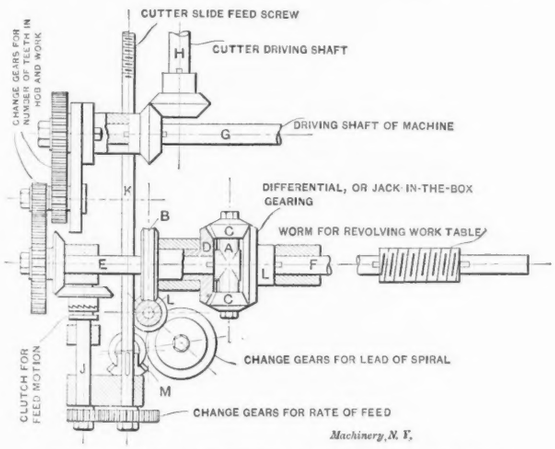

CUTTER SLIDE FEED SCREW
CUTTER DRIVING SHAFT
CHANGE GEARS FOR NUMBER OF TEETH IN HOB AND WORK
DRIVING SHAFT OF MACHINE
DIFFERENTIAL, OR JACK-IN-THE-BOX GEARING
WORM FOR REVOLVING WORK TABLE
CHANGE GEARS FOR LEAD OF SPIRAL
CLUTCH FOR FEED MOTION
CHANGE GEARS FOR RATE OF FEED
Machinery, N. Y.

Fig. 97. Typical Arrangement of Gearing for Spiral Gear Hobbing Machine.

will cause bevel gears *C* to roll around on stationary gear *D*, thereby revolving gear *L* and shaft *F* to which it is keyed, thus rotating the work table. The change gears connecting *G* and *E* are selected to give the proper ratio of movement between the hob or cutter spindle and the work table, to agree with the number of threads in the hob and the number of teeth in the gear being cut. The cutter slide feed-screw *K* is connected by change gears with shaft *J*, which is, in turn, connected through the clutch and the bevel gears shown with shaft *E*. The clutch furnishes the means of stopping and starting the feed, and the change gears serve to give the rate of feed desired. Change gears are also provided connecting bevel gear *M* on feed-screw *K*, with worm *L*, which drives worm-wheel *B*, running loosely on shaft *E*. By this means, supposing for the moment that shaft *E* and its attached cross arm *A* are stationary, the rotation of the feed-screw is communicated through the change gears to worm-wheel *B* and its attached bevel gear *D*, which, driving bevel pinions *C* on their stationary studs, revolve gear *L*, and with it shaft *F* and the worm driving the work table. In this way, by selecting suitable change gears, the work may be revolved to agree with the length of the lead of the spiral on which its teeth are formed, so that the cutter may be fed up and down through it without interfering with the teeth.

We thus see that the mechanism shown in Fig. 97 may be arranged to connect the hob and the work in the proper ratio, as for cutting spur gears, and also for connecting the feed-screw and the work in the proper ratio as for cutting spiral gears in the milling machine. But this mechanism not only performs these two functions separately, but it will perform them together, as well, so that either the feed or the cutter

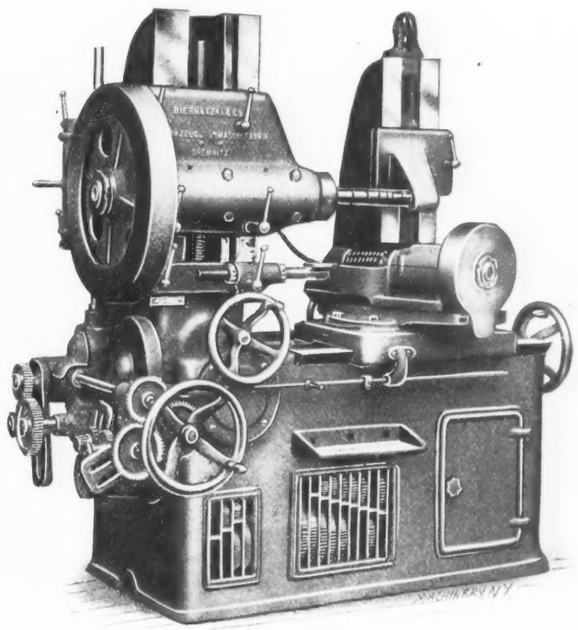


Fig. 98. Biernatzki Gear-hobbing Machine.

revolving mechanism may be started, stopped or reversed independently of the other movement, and the work will still be properly controlled under all conditions. The mechanism shown is not that invariably used, but it is typical of the arrangement employed in many hobbing machines designed for cutting helical gearing.

Hobbing Machines with Cutter Slide on Bed.

The first hobbing machine for spiral gears we show is that in Fig. 98, made by Biernatzki & Co., 60 Zschopauerstrasse, Chemnitz, Germany. This machine is built on the general lines of the orthodox automatic spur gear cutter shown in Figs. 21 to 28. The machine is stiffly constructed, the column and head being apparently made in one piece. A noticeable feature is the rigid construction of the outer work support. In a smaller size machine this is mounted on the front of the bed, but in the case shown it is supported on ways at the rear, behind the cutter slide. A rack and pinion movement, operated by hand-wheel, is provided for moving it toward or away from the column. This rapid adjustment is very convenient in changing the work. Three sets of change gears are used, as in Fig. 97. Those just behind the hand-wheel at the left are set for the lead of the spiral, those at the end of the bed are set for the feed of the cutter, while the ones at the rear are altered to give the proper ratio of movement for the number of teeth in the work and the hob. The arrangement of the machine in general is the same as

for its prototype, the automatic gear-cutter. One point of difference which may be noted is made necessary by the fact that the work is constantly revolving, instead of being intermittently indexed. The work support clamped to the face of the column in the regular gear-cutter is usually a simple abutment, adjusted by screw and nut to support the work against the thrust of the cutter. In this case, as may be seen, the support carries a disk or roller against which the work bears as it revolves.

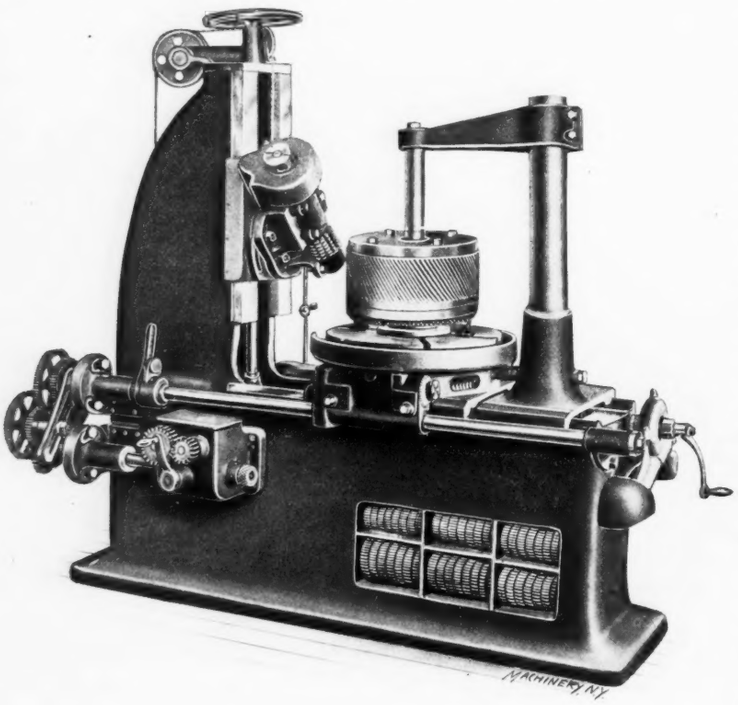


Fig. 99. Gear-hobbing Machine, made by Gould & Eberhardt, Newark, N. J.

Horizontal Form of Gear-hobbing Machines.

The Gould & Eberhardt hobbing machine, shown in Fig. 99, has previously been described in MACHINERY.* In this machine the "horizontal" form of construction has been adopted, in which the work is carried by a slide adjusted longitudinally on the top of the bed, while the cutter slide is mounted on the face of a vertical column, following thus the general plan of the machines shown in Figs. 30 to 39, and 53 to 57. This machine is rigidly constructed, the column and bed being in one piece, and special attention being given to the construction of the cutter head and work table to give the stiffness so necessary for accuracy and output in a machine of this kind. The outboard support for the work is particularly noticeable. It consists of a heavy post, carried by a slide working on the same ways as the work table, to which it may be connected to form one piece. A rapid traverse for the cutter head is provided, so that it is ordinarily unnecessary to operate the feed of the cutter slide manually. The cutter head may be swung around through an angle of 180 degrees above the horizontal. With this arrangement, the driving gear is always above the center line of the head, so that less clearance is required below the work. This means that blanks can be held down closer to the table, giving less overhang and greater rigidity. In Fig. 100 this machine is shown hobbing spiral gears.

In Fig. 101 we show a machine built by Holroyd & Co., Ltd., of Milnrow, near Rochdale, England. The engraving shows a spur gear in the machine having its teeth hobbed, but provision is made for hobbing spiral gears as well. As may be seen, the cutter spindle is driven by an internal gear of large diameter. The engraving shows quite plainly the usual method followed of supporting work in machines of this type. The work is centralized with the table by the arbor which passes through it, but most of the support is taken by brackets mounted on the table or face-plate, and provided with T-slots in their upper faces by which the work is clamped to them. This arrangement makes the work practically solid with the face-plate.

Of the three shafts extending along the front side of the bed, the lower one (*E* in Fig. 97) is connected with the cutter driving mechanism and drives through change and differential gearing the upper of the three shafts (*F* in Fig. 97) which is connected with the index worm of the work table. A place for change gearing will be seen at the base of the column carrying the cutter slide. This connects the feed movement of the cutter with the central shaft (*L* in Fig. 97) which in turn is connected with differential gearing in the enclosed casing seen at the right-hand end of the bed, in the foreground. In this, as well as in previous machines shown, provision is also made for hobbing worm gearing, the mechanism being introduced at the right-hand end of the bed for this purpose. Reference will be made to this later.

A still larger size of this machine is made, though for spur and worm gears only. This will operate on blanks up to 72 inches in diameter, and will cut gears up to 2 inches circular pitch by the hobbing process. The makers state that with these machines, the time for cutting a cast iron wheel of 84 teeth, 4 inches circular pitch, 2½ inches face, was 1 hour 21 minutes. Another one of the same pitch with 144 teeth, 3 inches wide, took 2 hours. Reckoning on the basis of 84 teeth, this would make about 6 inches feed per minute, and allowing for about 3 feet a minute quick return, an automatic gear-cutter would barely be able to accomplish this.

In both of these machines provision is made for intermittent indexing, so that a formed gear-cutter can be used. For this purpose the lower shaft in Fig. 101 may be driven through a friction slip if desired. The lever shown below the differential gear box at the right-hand end may be used to release or arrest a disk keyed to this shaft, so that it may be allowed to make one revolution when desired. The change gears at the end of the machine are then set for the number of teeth required. Under these conditions it will be seen that it may be used for gear-cutting by the formed cutter method, being then practically the same sort of machine as those illustrated in Figs. 33 to 36, except that it is not fully automatic.

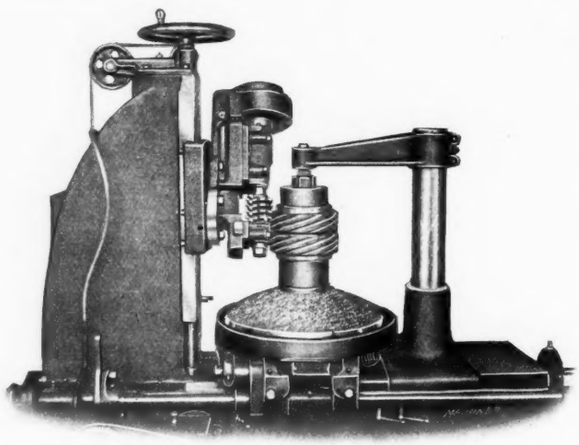


Fig. 100. Gould & Eberhardt Machine cutting Spiral Gears.

In Fig. 102 is shown a gear-hobbing machine* built by the Newton Machine Tool Works, Inc., Philadelphia, Pa. It is shown at work on a spiral gear, which is supported in a somewhat different manner from the cases previously shown.

* See "New Machinery and Tools" in the November, 1907, issue of MACHINERY.

* See "New Machinery and Tools" in the December, 1907, issue of MACHINERY.

A special support, in the form of a cast sleeve or column, is provided for raising the work high enough above the table so that the driving gear of the spindle clears the table when the cutter has been fed through the work. In cutting spur gears, of course, it is not necessary to set the work so far above the table, less clearance being required for the spindle driving gear.

The Pfauder machine, shown in Fig. 103, is sold by Schuchardt & Schütte of New York, Berlin, London, etc. The differential mechanism is shown quite plainly in this engraving, which represents the No. 4 machine. The change gearing above the index worm shaft is for the lead of the helix, that below, for the feed, while the larger gearing at the left end of the machine is for connecting the hob and the work in the proper ratio. The cutter spindle of this machine is driven by herring-bone gears to insure smoothness of action. This line of machines is made in a great range of sizes. The smallest of these has a maximum capacity for a blank 6 inches in diameter, while the largest will take a gear 104 inches in diameter. Provision is made in the larger sizes for intermittent indexing of the work table by hand, so that the teeth may be cut by formed cutters if desired. The swiveling head is adjusted by a worm on the larger sizes.

Hobbing Machines of Special Types.

The machine shown in Fig. 104, made by the Grant-Lees Machine Co., 6901 Quincy Avenue, Cleveland, Ohio, cannot be classified structurally with any of the previous examples. It is an outgrowth from a hobbing machine for worm gears, formerly built by its designer, Mr. John Grant. It has previously been described in MACHINERY* where its novel features have been explained. The work is mounted on a vertical spindle, carried by a slide which is adjusted horizontally for the diameter. The feed of the cutter through the work is effected by raising the spindle vertically. The cutter is driven by a combination of bevel gears which is best shown in Fig. 105, and it may be adjusted throughout a full circle. The bevel gear on the hob spindle meshes with a large ring bevel gear, which in turn is driven by a bevel pinion on the driving shaft. The bevel pinion on the hob shaft occupies a different portion of the ring bevel gear from that occupied by the driving pinion, so it may be adjusted around the full circle without interference. Provision has been made in the mechanism to revolve the work as it is fed upward, independently of the movement given by its connection with the hob, thus meeting the requirements for spiral or helical milling. The machine is shown in Fig. 105, completing a helical gear.

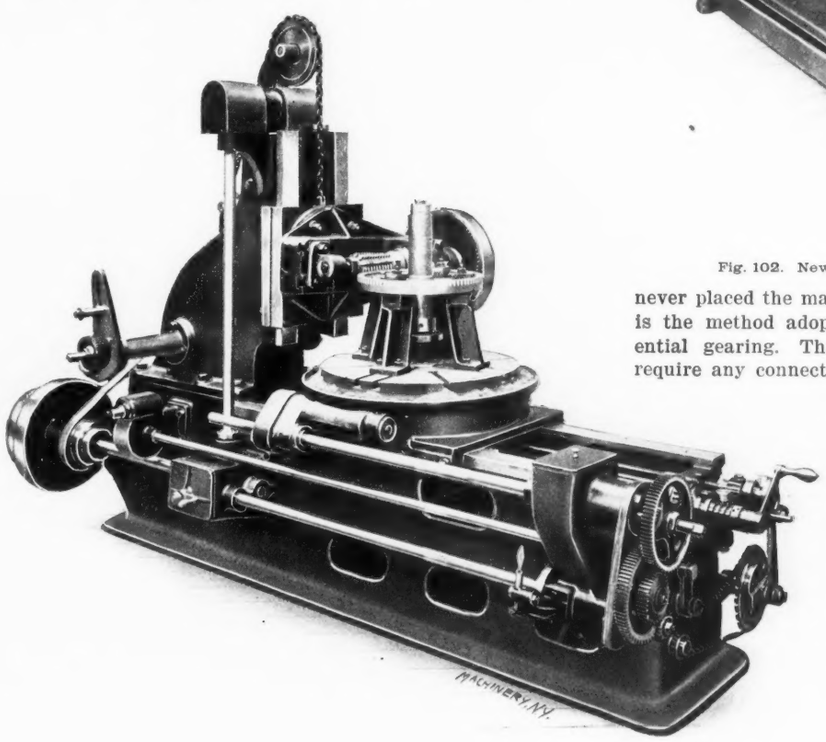


Fig. 101. Holroyd Gear-hobbing Machine. Though shown cutting Spur Gears, it will cut Helical Gears as well.

A gear-hobbing machine, built by Geo. Juengst & Sons, Croton Falls, N. Y., is decidedly worthy of study on account of the unique principle involved, although the builders have never placed the machine on the market. The unique feature is the method adopted for avoiding the necessity for differential gearing. The spur gear hobbing machine does not require any connection between the feed-screw and the work-revolving mechanism, because the hob can be fed back and forth through the work after it has been completed, without interference. In the Juengst machine the same effect is accomplished by setting the feeding movement at the angle of the teeth of the work. As is shown in Fig. 106, the work is mounted on the column, while the cutter, which may be swiveled to agree with its helix angle, is fed along a slide which may be, in turn, swiveled to agree with the helix angle of the work. The line of travel of the hob, as shown in Fig. 107, being thus set in the same direction as the teeth of the gear, the hob can be fed diagonally through the work without interfering with the teeth, whether the machine is in motion or not, it being taken for granted, of course, that the hob and the work are properly geared together. Differential gearing is thus done away with, being replaced by the swiveling adjustment of the cutter slide, which permits the line of travel of the hob to be adjusted to the helix angle of the work.

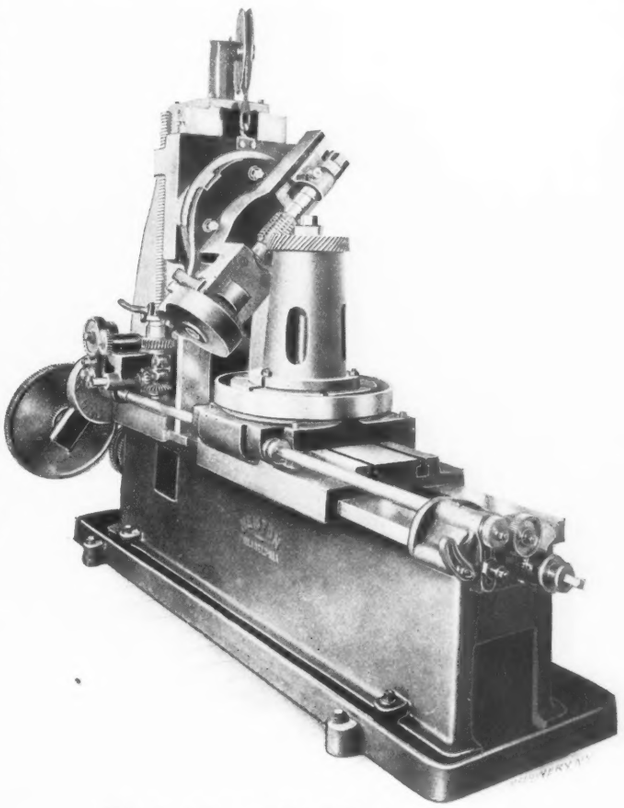


Fig. 102. Newton Machine at Work on a Helical Gear.

This same result has been accomplished in another way by a patent granted to an English inventor. With his arrangement the work is mounted on a table on the bed, while the cutter slide feeds up and down the column as in the orthodox arrangement for hobbing machines, shown in Figs. 53 to 56

* See "New Machinery and Tools" in the October, 1907, issue of MACHINERY.

and 99 to 103. The column, however, instead of being solid with or bolted to the bed, is mounted on ways so that it may be fed horizontally at right angles to the line of adjustment of the work table. The feed-screw controlling this adjustment is connected by change gearing with the vertical feed-screw of the cutter slide on the column, so that these two movements take place simultaneously in any desired ratio

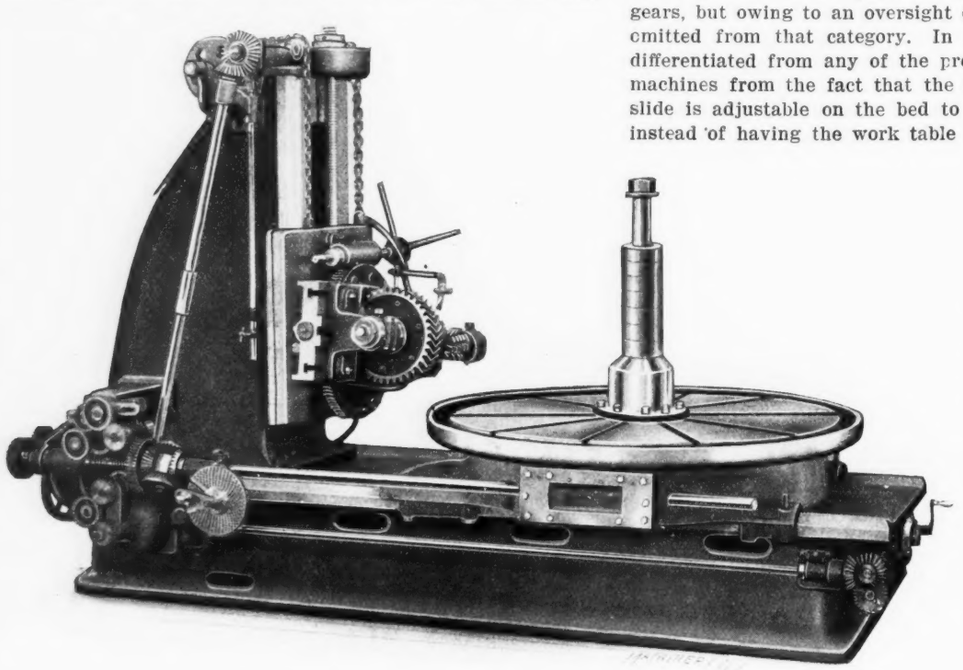


Fig. 103. Pfauder Gear-hobbing Machine, sold by Schuchardt & Schutte.

with each other. By this means the combined vertical and horizontal movements of the cutter slide give a component in an angular direction, which may be made to give any desired angle of travel, such as that shown, for instance, in the line of travel of the hob in the Juengst machine, Fig. 107.

The difficulty with this otherwise attractive plan for hobbing helical gears by moving the hob at an angle instead of using differential gearing, appears to be that a longer hob is required for going in an angular direction across the face of the gear, than would be necessary in feeding vertically downward, as is the case with the usual differential mechanism. The hob would have to be unusually long if it were desired to cut a bank of spiral gears in one operation, as is being done in Fig. 99.

There are still other methods possible for taking care of the helical movements required besides those already discussed. For instance, instead of using differential gearing to combine the motion derived from the feed-screw with that of the index worm shaft, it may be used to combine movements derived from the feed-screw with that of the cutter spindle driving shaft. Furthermore, the differential mechanism may be discarded entirely, by providing an index worm of considerable length and shifting it longitudinally at the proper rate in connection with the feeding of the cutter slide. This would impose on the work rotation in connection with the cutter slide feed without interfering in any way with the rotation due to the connection with the cutter or hob. Differential gearing would thus be avoided as in the case of the Juengst machine. This device would have its limitations for gears of small lead, as it would require too great a length of worm to give the proper amount of rotation to the work.

Another interesting spiral gear hobbing machine which has been described in MACHINERY* is that furnished by the Pratt & Whitney Co., of Hartford, Conn., for cutting the wonderful herring-bone gears, run at such tremendous speed in the De Laval steam turbine. A particular feature of this machine was the provision for correcting by a link motion the slight inaccuracies inherent in the use of change gears for obtaining exactly the lead required for the helical teeth it is desired to cut.

In Fig. 108 is shown a gear-hobbing machine made by Maschinen Fabrik Lorenz, Ettlingen, Baden, Germany. This machine should properly be shown among the spur gear hobbing machines, as no provision is made for hobbing helical gears, but owing to an oversight on the writer's part, it was omitted from that category. In its structural design, it is differentiated from any of the previous examples of hobbing machines from the fact that the column carrying the cutter slide is adjustable on the bed to the diameter of the work, instead of having the work table adjustable. In this respect it resembles the hobbing spur gear cutting machines using formed cutters, illustrated in Figs. 37, 38, and 39. The machine is made in several sizes. The example shown, which is next to the largest size, will take work up to 110 inches in diameter.

Spiral gearing is cut on this machine in a way analogous to that followed in the Reinecker universal machine shown in Figs. 85 and 86, although the provisions for indexing are entirely different. A formed cutter is used, which is fed down through the work, the latter being revolved in unison with the feeding as in the case of the universal miller. The indexing is then effected by change gears and the one revolution crank shown at the side of the base in the engraving. In indexing, the dividing worm is connected with the index gearing and disconnected from the spiral mechanism; after

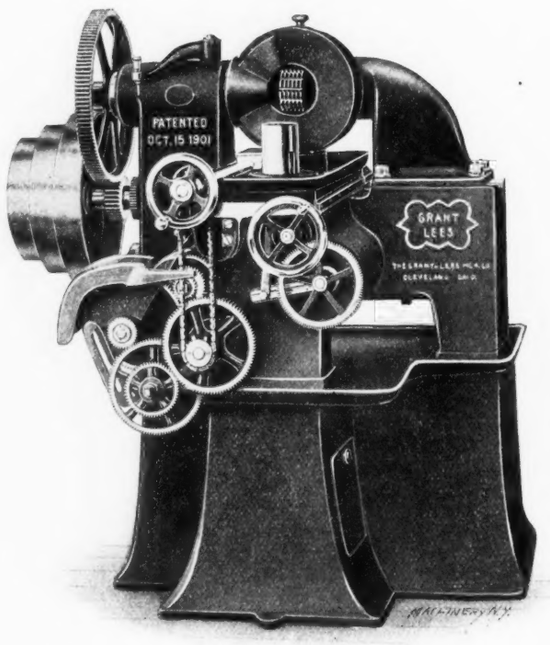


Fig. 104. Gear-hobbing Machine of Special Construction, made by Grant-Lees Machine Co., Cleveland, O.

the indexing, the connection is again made with the spiral mechanism, while the indexing motion is released. The index or work-driving worm-wheel is of bronze, driven by a worm of special construction, which the builders claim gives a much more durable contact than is ordinarily obtained.

* See "The De Laval Steam Turbine and its Manufacture" in the November, 1904, issue of MACHINERY.

It would appear from the drawings furnished the writer that the Reinecker universal gear-cutting machine (see Figs. 85 and 86) could be arranged to hob spiral gears by the simple expedient of connecting the indexing change gear train positively with the cutter driving mechanism instead of through the friction slip used for the semi-automatic in-

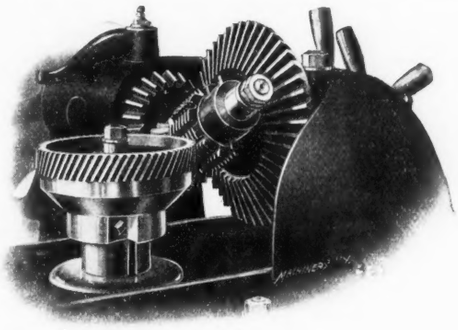


Fig. 105. Grant-Lees Machine hobbing a Helical Gear.

dexing. This would give a combination identical in principle with that shown in Fig. 96. Probably the matter of German patent infringements accounts for not using the machine for hobbing spiral gears.

Besides the machines we have just described, two of the hobbing machines illustrated and described under the heading of spur gear machinery are adapted to the cutting of helical gears as well. These machines are the Rhenania machine shown in Fig. 54, and the Wallwork machine shown in Fig. 56. The only change necessary to adapt these machines to cutting spiral gears is the addition of the differential gearing, and the connection for change gearing between the feed-screw and the work table revolving worm. Provision is made for this mechanism in the design of the machines. Of course all of the hobbing machines we have described are adapted for cutting spur gears, and those shown in this installment of this series should be included in the list when studying spur gear cutting machinery.

The Field of the Hobbing Process for Cutting Helical and Herring-bone Gears.

There are some limitations to the hobbing process of cutting helical gears. It is not particularly successful in the

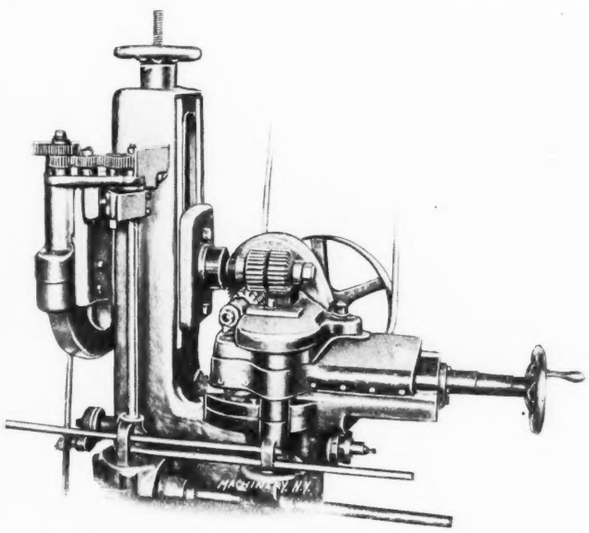


Fig. 106. Juengst Gear-hobbing Machine; uses a Novel Principle of Helical Milling.

cutting of gears of such small lead and great helix angle that they would be classed as worms, rather than spiral gears. For such cases, the rate of rotation which has to be given the blank is so great in proportion to the downward feed of the cutter by which the rotation is effected (through the change and differential gearing) that it is almost impossible to drive it, the difficulty being the same in kind, though reversed in direction, as that met with in cutting very steep pitches in the lathe. By a slight complication of the machine, however, mechanism could be introduced to overcome this difficulty, and make the hobbing machine universal for all kinds of gears within its range.

In the discussion of the hobbing processes for cutting spur gears, it was stated that its field was not yet definitely determined. It may be said, on the whole, that there is no such indefiniteness in regard to the field of the hobbing machine for cutting helical gears. With a well-constructed machine and with hobs of proper shape, spiral gears can be cut more accurately and cheaply by this method than by any other known. There are none of the mechanical difficulties of indexing and relieving to be taken care of as is the case in automatic machines working on the formed cutter process; and there are none of the uncertainties as to tooth shape due to interference met with in cutting a helical groove with a formed cutter, as shown in Fig. 80. There has been some little difficulty in getting the correct shape of teeth by the hobbing process, due to the elasticity of the mechanism connecting the hob and the work, and to errors in the construction of the hob itself. These difficulties, however, will surely disappear with further experience and investigation.

Apparently the recent rapid development of the hobbing process for cutting spiral gears is the solution of a problem which has long seemed somewhat perplexing. The flexibility of the spiral gear, and the numerous advantages of the her-

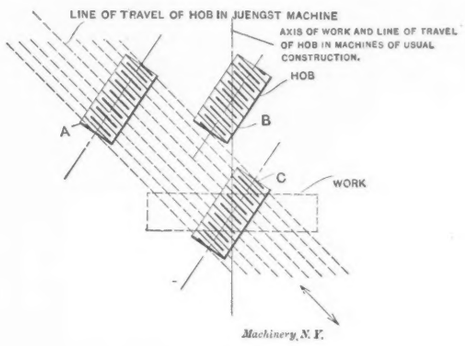


Fig. 107. Method of Feeding the Hob in the Juengst Machine.

ring-bone or the twisted tooth spur gear for transmitting great power noiselessly and smoothly even at high velocities, have long been appreciated, but their extended use has waited for the development of some accurate and inexpensive method of forming helical teeth.

MACHINES FOR FORMING THE TEETH OF WORM-WHEELS.

To correctly classify and comprehend the various methods and machines for cutting the teeth of worm-wheels, it is first necessary to clearly define the term "worm gearing." We will consider that by worm gearing we mean gearing of the type of which a cross-section is shown at the right of Fig. 109, in which the acting face of the wheel is curved to fit the form of the worm, and in which the whole width of the wheel face is in active working contact with the worm.

The action is best understood by taking vertical sections on the center line *A-A*, and other lines such as that at *B-B*, parallel with the center line. Sections on lines *A-A* and *B-B* are shown at the right of the cut. With worm gearing of standard form, the section on line *A-A* shows the worm to have the profile of an involute rack, while the teeth of the wheel show outlines identical with those of the corresponding involute gear of the same pitch and number of teeth, suited to engage with the rack. In other words, the teeth of the gear are such as would be formed by the teeth of the worm if the latter acted as a rack in a molding-generating operation identical with that shown in Fig. 7. A section on line *B-B* shows that the teeth of the worm have a distorted outline on planes removed from the axial plane. If we consider these distorted teeth as the teeth of a rack, molding their mating tooth spaces in a gear running on the same center as the worm gear and at the same speed, it will form, by the process of Fig. 7, the distorted wheel teeth shown

for the section on line *B-B*. In a word, each section of the worm parallel to the axial section *A-A*, is a rack section, which molds in the wheel below it the proper teeth to mesh with it in accurate conjugate action. The true worm-wheel, it is thus seen, must be formed by the molding-generating process.

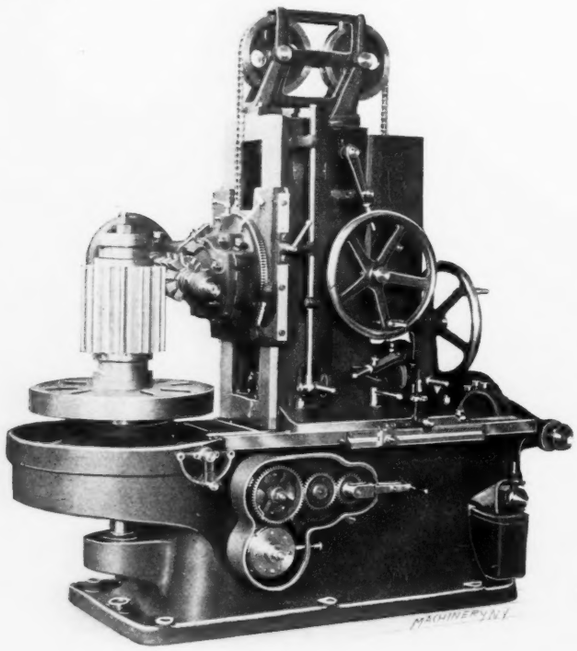


Fig. 108. Lorenz Gear-hobbing Machine.

The same worm as that shown in Fig. 109 may be made to engage with a spiral gear of the same number of teeth as the worm-wheel, provided the teeth are of the proper pitch and set at an angle to agree with the helix angle of the worm. The action of such gearing, however, does not, like that in Fig. 109, take place on all sections *A-A*, *B-B*, etc., but is confined to a point at or near the center line *A-A*. The contact, in other words, is point contact, and not line contact extending clear across the face of the wheel. Such a combination, in fact, is not a case of worm gearing, but a case of spiral gearing—and a very poor case at that.

Gashing Worm-wheels by the Formed Cutter Process.

While the method of forming a true worm-wheel is thus seen to be accurately performed only by the molding-generating process, the accurate teeth produced by that process may

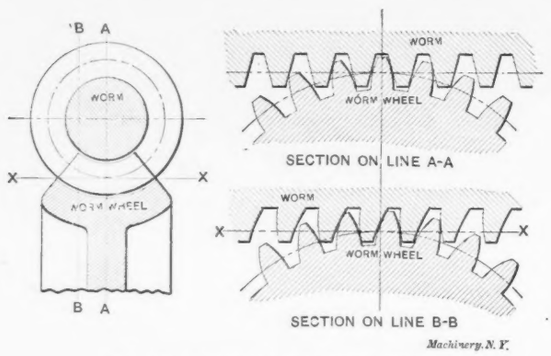


Fig. 109. Action of a True Worm-wheel.

be closely approximated in many cases by the "gashing" method, which belongs in the formed cutter classification. In this operation, illustrated in Fig. 110, a milling cutter is used, having approximately the outline of a normal section of the teeth of the worm to be used. This cutter is of the same diameter as the worm, and is set with relation to the axis of the work at the helix angle of the worm, as measured on the pitch line. It is centered over the wheel, and fed into the latter to the proper depth to form a tooth space; it is then drawn out again, the work is indexed to the next tooth space, and the cutter again sunk in to depth, the operation being repeated until the wheel is completed. In Fig. 110 a universal milling machine is being used for this operation.

With the table set at 90 degrees, the cutter is first brought centrally over the work arbor by adjusting the saddle on the knee of the milling machine, and then the work is brought centrally with the cutter arbor by adjusting the table by the feed-screw. The work table is next swung to the helix angle of the worm which is to be used with the wheel. Then the cutting is proceeded with.

This gashing process gives a tooth very closely approximating the true tooth form, when the diameter of the worm is large as compared with the pitch, and when the worm is single threaded. For multiple threaded worms of smaller diameter in proportion to their pitch, the process is impracticable. This method is used by at least one of the best known builders of gear-cutting machines in forming the teeth in the index worm-wheel. It is used under the conditions which give a very close approximation to the true form of tooth, and is employed in this particular case for the sake of the high degree of accuracy obtainable. The index wheel is divided, in cutting, by a carefully-made and carefully-preserved master wheel. The step by step gashing process allows the spacings of this superior master wheel to be accurately reproduced in the index wheel being cut—more accurately

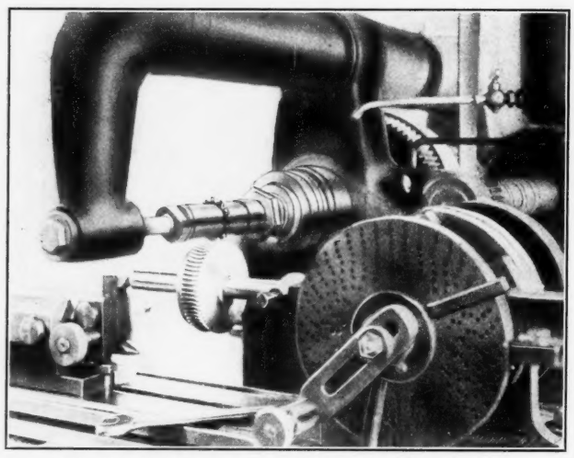


Fig. 110. Gashing a Worm-wheel in the Milling Machine.

than would be possible if it were to be reproduced by the hobbing operation.

The gashing process is also used for roughing out worm-wheels preparatory to hobbing. In a previously gashed wheel, as will be explained later, the hobbing operation is one of extreme simplicity, not requiring special machines or mechanism of any kind.

The discussion of methods and machines for hobbing worm-wheels will be continued in the next issue of MACHINERY.

* * *

The Northern Railway of France has recently conducted some tests for the purpose of comparing the superiority of locomotives of the 4-cylinder double bogie Mallet type, with two 6- and 8-wheel coupled freight engines of smaller design. According to the *Mechanical Engineer*, the tests were made on two trains weighing each 950 tons. One was hauled by the two smaller engines, and the other by one Mallet locomotive. The trials extended over a period of six months, the distance run being about 12,500 miles in each case. The fuel consumed by the Mallet engine cost $458, as compared with $582 for the two smaller engines. The cost of lubricants and up-keep cost for the Mallet engine amounted to $85 as compared with $90 for the smaller engines. The wages for the men employed on the Mallet engine amounted to $219, as compared with $369 for the smaller engines. Thus, the total sum of running expenses for the Mallet engine amounted to $762, as compared with $1,041 for the 6- and 8-coupled engines, running in tandem. The first cost of the Mallet engine was $23,300, and the two 6- and 8-coupled engines used cost, together, $30,100, so that the capital saved by using engines of the newer type is nearly $7,000 per locomotive.

NOTES FROM THE NEW SHOPS OF THE HEALD MACHINE CO.

The Heald Machine Co. was incorporated in September, 1903, and succeeded to the business of L. S. Heald & Son, of Barre, Mass. The business in Barre was established by Stephen Heald in 1830, and for forty or fifty years this shop was the principal machine shop within a radius of 20 or 25 miles. While the business consisted largely of building agricultural and wood-working machinery and doing work of a local nature, large numbers of wire-drawing machines were constructed, which were sold to the most up-to-date wire manufacturers of that time. A foundry was also established in connection with the machine shop and at that time was the only foundry within a radius of 25 miles, all iron and coal being teamed that distance from the nearest railroad.

About 1860, two sons of Stephen Heald were taken into partnership under the firm name of S. Heald & Sons. In 1890, after the death of Stephen Heald, one of his sons, Leander S. Heald and his son, Jas. N. Heald, carried on the business under the firm name of L. S. Heald & Son until the year 1903, when the need of better shipping facilities (the nearest railroad then being located three miles from the factory), better labor market, and growth of the business, led to its removal to the city of Worcester, the senior partner, L. S. Heald, selling his interest to his son, Jas. N. Heald, who organized the company known as the Heald Machine Company, of which he is treasurer and manager.

For the last twenty years special attention has been given to the manufacture of grinding machinery, the line first beginning with the American twist drill grinder, which has had a wide sale, not only in this country but also in many foreign countries. Later, this line was increased by a line of grinding attachments and center grinders for use in connection with lathes, and later yet a line of ring and surface grinders was brought out for grinding piston rings, disks, dies, and similar work, this being known as the Heald ring and surface grinder. The attention of the company was then called to the importance of furnishing the automobile manufacturers with a machine which would grind the interior of the cylinders for their engines so that a better surface could be produced than by boring and reaming.

While previous practice in steam engines having thick cylinder walls had been to smooth bore for a finish, and, in some of the smaller sizes, ream for the same purpose, this was not a satisfactory method in finishing automobile engine cylinders having thin walls which spring under the pressure of the boring tool and reamer. Therefore, a method of finishing these cylinders which would produce a more perfect surface and uniform diameters was greatly needed. The company took up the study of the problem and developed a machine for accomplishing this work, known as the Heald cylinder grinder. This machine has been adopted by almost all the leading automobile manufacturers of this country, and many of the machines have been shipped to England, France, Germany, and Italy for the same service. The latest tool brought out by the company is a new internal grinder which has just been put on the market.

Fig. 1. View of Central Bay in the Heald Machine Co.'s Shop, showing Section devoted to Assembling of Machines.

Fig. 5 shows the well-known cylinder grinder built by the company, under inspection test. It will be noted that the machine is built according to the unit system,—that is to say, the different portions are grouped into units as shown in Fig. 6, which is a part of the latest machine brought out. These units are afterward assembled to the frame or bed by suitable fastenings. This accords with the most modern practice and is undoubtedly a time-saver. Carborundum wheels are recommended for internal grinding on cast iron parts. The writer noted, however, that the carborundum wheels in

stock were not made by the producers of carborundum, but by another firm.

The works of the company are located in Greendale, a suburb of Worcester, directly across the street from the works of the Norton Co., and the Norton Grinding Co., making a sort of grinding settlement at this point. The shops were enlarged during the past summer, an addition of 150 feet by 90 feet being made to the main building, and wash room and toilet rooms covering a space of 30 feet by 45 feet being built in addition. This, with the new power house 26 feet by 43 feet, gives a total floor area, at the present time, of over 28,000 square feet. The number of employes before the present falling off in business was from 90 to 100.

In regard to shipping facilities, the works are located directly on the spur of the Boston & Maine Railroad system, so that cars are loaded directly at the door for shipment to any section of the country. The cuts, Figs. 1 and 2, show two views of the general arrangement of the shop. All the rooms are well lighted and ventilated, and this, together with the modern wash-room, Fig. 3, makes a very pleasant place in which to work. In all the arrangements for handling the work a complete business system is maintained, and the exact standing of manufacture in any or all of the departments is known at all times.

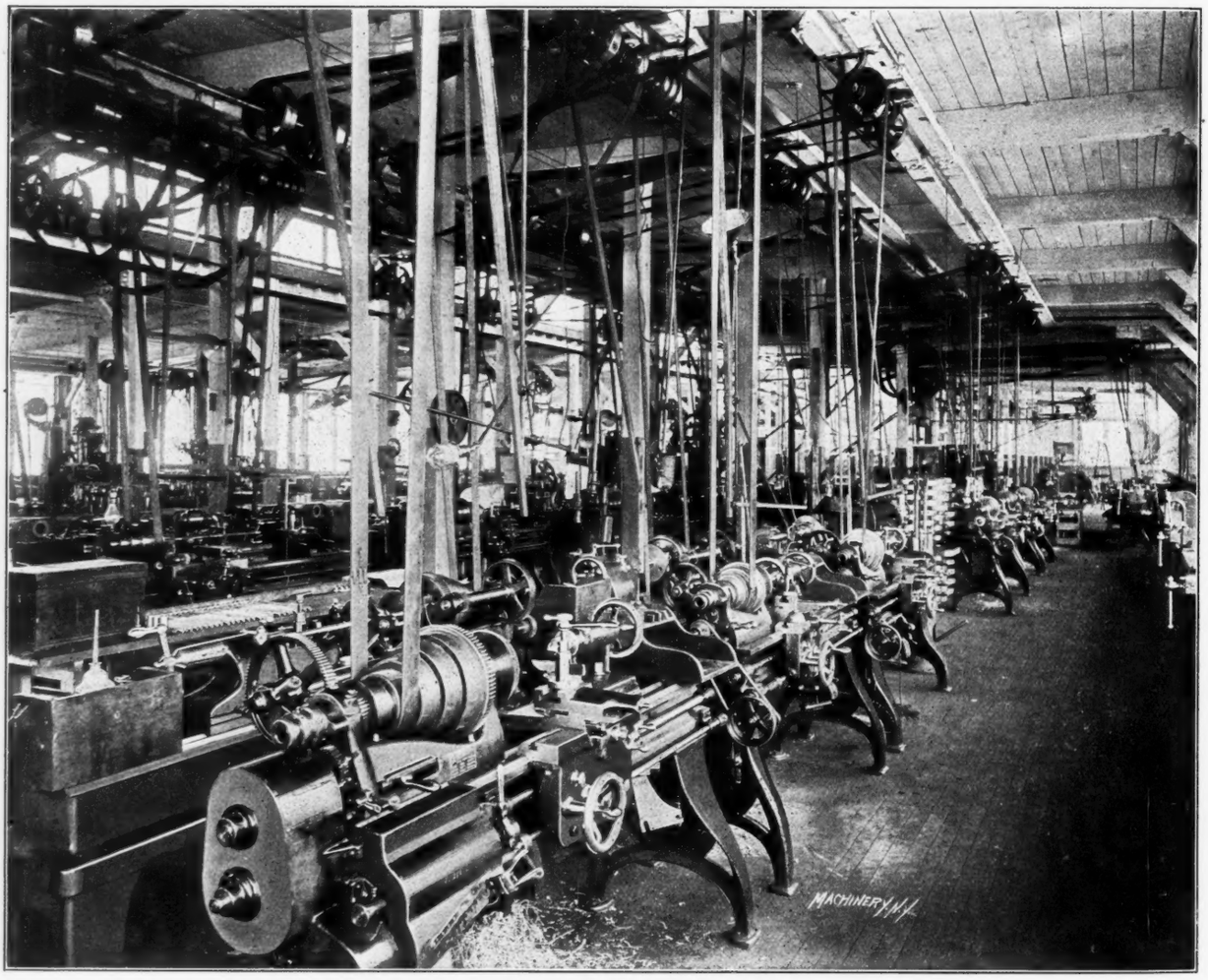


Fig. 2. Lathe Department, showing the Light and Neat Appearance of the Factory.

Outline of the Heald Machine Co.'s Shop System.

In originating the stores system in use in the factory, the Heald Co. goes on the principle that a satisfactory cost system and a well-kept and well-organized stores-room go hand in hand. Fig. 4 shows a rack for holding bar stock. As this stock is of varying grades, each bar has its own color denoting its particular grade. For example, soft machine steel might be denoted by yellow, wrought iron by red, hard machine steel, blue, etc. One end of each bar is painted the denoting color when the stock is received, and the cutting off is from the unpainted end. All bar stock is cut in the stores-room.

While the stores-room can do fairly well without the cost system, the latter is a failure without the former. By that is meant that one of the factors in cost work is the material used, and unless all material is handled correctly, and properly issued to the department and to the work on which it is used, the figures obtained by the cost department would be proportionately inaccurate. The Heald Co. has, therefore, so arranged the stores-room that all material is received by that department, and complete records are kept of all material in stock (which amounts to a perpetual inventory of stock on hand), and of the proper distribution of stock, same being issued against the shop orders on which that material is to be used. There is no question but that a well-handled stores-room pays for itself many times over because of the fact that the stores department is constantly on the lookout for the future needs of the factory, and sees that the material is on hand, and that it is so kept that it can be found when wanted, which cannot be the case if material is handled in such a way that any one of the workmen can help himself to it, or when some one endeavors to anticipate the needs of the factory without some good system connected with the use of the material. So simple and yet so complete is the system installed that but three people are required to receive, keep careful record of, and issue all the stock to the factory, do the time-keeping, and figure all the cost connected with the product, for a force of from seventy-five to one hundred workmen. The same stores-room force could well take care of from 25 to 50 per cent more men.

The system originates or starts from the "production department," which issues what is called an "assembly factory order." This order covers all the work done and material

used in the manufacture and assembling of a definite number of machines of a certain kind. After the assembly order is issued, the drawing-room furnishes the factory with several sets of complete drawings showing every part used in the construction of the machines. It also furnishes, at the same time, to the production department and stores department, what is known as a schedule of parts used in the construction of the machines. This schedule shows every part used on the

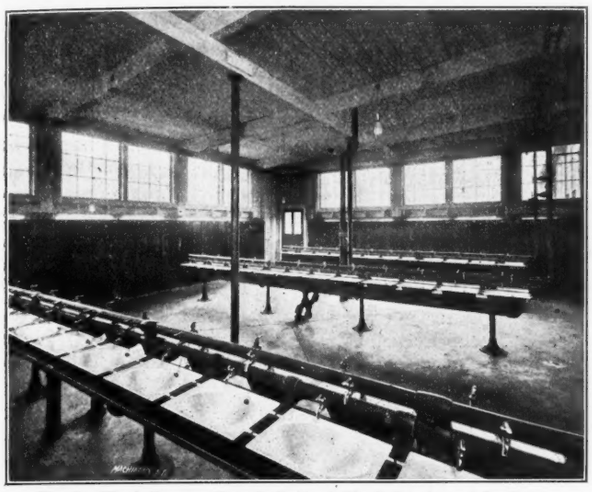


Fig. 3. Wash Room. Note Individual Wash Bowls and Lockers, and Spacious Accommodations.

machine, gives the name of the part, the part number, shows how many parts of each kind are used on the machine, the material of which each part is made, and gives the rough dimensions from which the stores department makes up requisitions for the stock that will be needed to build the different parts. The schedule also gives the number of the blue-print on which each machine part is shown.

When the production department receives the schedule from the drawing-room, individual shop orders are made up for the number of each piece required for the lot of machines. These orders are made in triplicate, one copy going to the time-keeper, one copy to the stores department, and one copy to the foreman of the department in which the first operation on that particular part takes place. Immediately upon receipt of the shop orders, the stores department makes out what is called "traveler tags." These tags are held by the stores department until the material is ready for the factory, at which time they are delivered to the superintendent, who sees

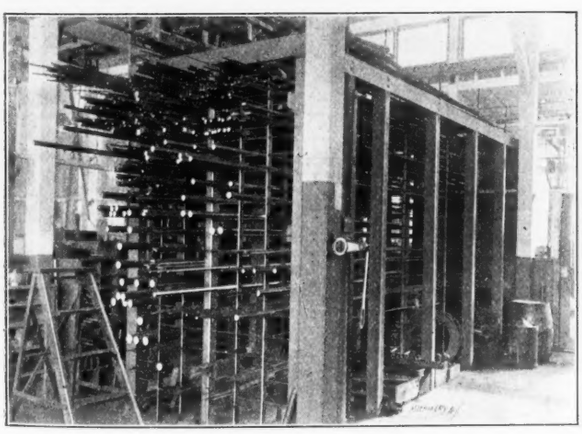


Fig. 4. Rack for Holding Bar Stock.

to it that the foreman of the department in which the first operation on the piece takes place receives the tags, each being withheld, however, until the superintendent is ready for that particular job to go through. On the back of the traveler tag is indicated the list of operations in the order in which they are to be performed. The names of the various operations are printed, and in a column in front of the name of the operation a number is placed in ink or pencil, indicating the order of the operations for the particular piece in question.

When the foreman of any department is ready to commence work on any part, he hands the workman the traveler tag for that part, which this man then presents to the stores department delivery window. He receives the stock for making up the required number of parts, after which he presents the tag to the time-keeper's window and receives his time-card, together with the proper blue-print, for which he leaves a brass check with the time-keeper, going from there directly to the time-clock, where he rings "in" on the time-card. The time-clock in use is known as the "Rochester."

After ringing in, the workman is ready to proceed with the work. He rings "out" on the time-card when leaving off work at any time, and rings "in" on the same card when commencing work again. When each operation, however, on those parts is finished, he must change his time-card for a time-card covering the following operation. This is done in order that the cost of each operation may be known, and thereby the company be in position to make comparisons of labor cost, and ascertain whether one man is a more skilled and a better producer than another. This information is valuable in order that proper adjustments of wages may be made, and is a very valuable feature for the workman, especially a good one, for when an increase in his pay is under consideration, records are ready at hand from which to determine whether or not he is worthy of an increase.

The inspection system calls for the inspection of all work after each operation. It also calls for the immediate inspection of the first part finished on each operation. The piece when finally inspected as a completed machine part is turned

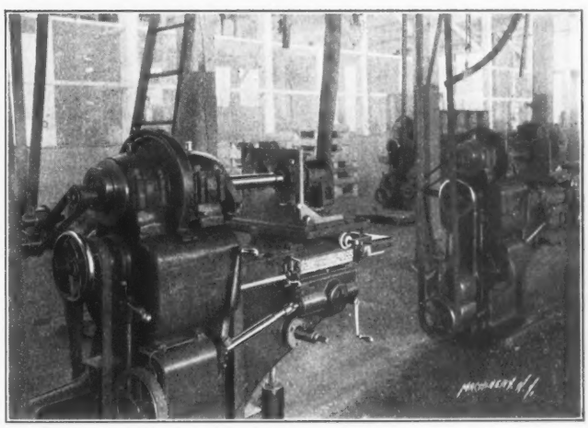


Fig. 5. Heald's Internal Cylinder Grinder under Inspection Test.

in to the stores-room by the inspector, who alone has authority to turn in material to the stores department from the factory.

Upon receipt of these finished parts by the stores department, they are placed on the shelves to await the assembling of the machines, at which time they are drawn out of stock and charged against the assembly order, the same as other material. The copy of the order originally sent to the stores department is turned in to the time clerk, who immediately proceeds to figure the cost of all operations on the part, material used, factory overhead charges, etc., making a record of these costs on a cost record card.

When the stores department issues material to the factory, the workman taking out the material fills out a blank headed "Storekeeper: Please furnish:". These blanks are each day turned over to the stock clerk, who enters on his stock sheets the material shown as given out. It sometimes happens that material is given out to the factory and afterwards returned, at which time a credit is rendered to the shop order on which it was originally issued. Such a credit is made out on a pink slip headed "Storekeeper: Please credit:". These issues and credit slips are turned over weekly to the cost clerk, and represent the actual material used for the shop order on which those parts are made up. On these issue slips the value of the material appears. This is written in by the cost clerk, who takes the prices from his stock sheets.

In order that the cost clerk may have correct prices for this purpose, the following purchasing system is in use: When purchased stock is needed, the stores-keeper notifies the pur-

chasing agent. When the purchase order is made out by the purchasing department, a copy of this order is sent to the stores department, who receives the material when it is delivered, and fills out a "voucher for material received." This voucher is handed to the purchasing department, who audits the invoice, and writes in the cost of the material, after which the voucher is returned to the stores department, where the price is transferred to the stock sheets.

There is one feature of the system that differs quite radically from many we have seen, which is that none of the foremen are called upon to do clerical work of any kind. The system is carried through the works entirely independent of the foremen, giving them all of their time to attend to their work as foremen, and leaves the clerical work to others who are better fitted for the work, and who, as a general thing,

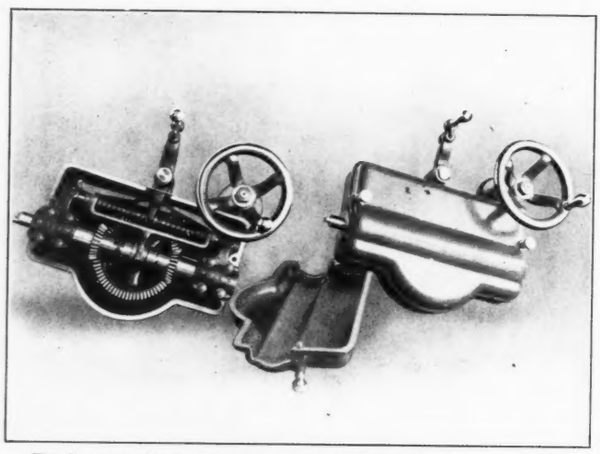


Fig. 6. Example showing Principle of Unit Construction followed in the Design of the Heald Co.'s Machines.

can be hired for less money. We are aware of the fact that a large number of manufacturers question the wisdom of going to the expense incurred by a satisfactory stores department and cost system, but the Heald Machine Co. claims that a very simple and inexpensive system, like that in force, will save any firm many times the actual cost of the system. Probably the greatest difficulty with those who question the wisdom of a cost system has been that the systems they have seen in force, or been in contact with, have been so loaded down with "forms" and "red tape" that the system became a burden rather than a help.

In preparing this article we are indebted to Mr. Heald and to his superintendent, Mr. Cowan, for much of the material.

* * *

MACHINE SHOP PROVERBS.

Hell hath no fury like a loose pulley scorned.

A fair exterior may be but a whited sepulchre for prick-punch fits.

A rusty nut will hang as plumb as a mercury bob.

The right thing in the right place—lard oil for the tap, black strap for the spindle.

"Were there "putting-on tools," then would be one man as good as another.

Better the mote in another's eye than the emery in one's own.

Lathe tail-centers were made before center reamers,—but be civilized.

That a man is a tool-maker does not make him a Joshua Rose.

* * *

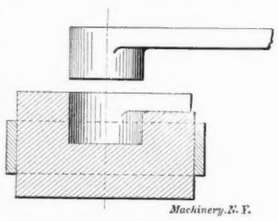
In the February issue of MACHINERY reference was made to the new railway ferry connection proposed between Sweden and Germany, which will be the most remarkable railway ferry connection for both passenger and freight service in the world. The bill for the establishment of the ferry service has now passed the Swedish parliament. Four ferry boats are to be built, and direct communication will thus be provided between the government railroads of Sweden and Germany. The cost for the establishment of this ferry connection is about $2,500,000.

DROP AND STAMPED FORGINGS.*

JOSEPH HORNER.†

Joseph Horner.‡

The employment of drop forgings and stampings increases constantly and rapidly. Several firms are now equipped wholly for this class of work, and supply enormous numbers of forgings to the metal working trades. Drop forgings or stampings bear the same relation to the work of the blacksmith shop that machine-molded castings bear to that of the foundry. In each case the skilled labor of the craftsman is dispensed with, yet good wages are earned by men working by the piece. In each case the cheaper product has the advantage of much greater accuracy, and uniformity in shapes and dimensions. The numbers turned out from the dies or stamps, as from the molding machines, are often twenty or thirty times as great as those which can be produced by hand by skilled men. In each case, too, the question of machining is often inseparable from that of the methods of production adopted, because accuracy of shape, and uniformity of dimensions in forgings and casting alike are favorable to the most economical machining, since allowances which are either insufficient or excessive for the machines are equally undesirable and troublesome. The smith working at the anvil, even with the aids afforded by templets and gap gages, is unable to produce two pieces, to say nothing of twenty intricate and elaborate pieces, absolutely alike, unless at an enormous expenditure of time. It is cheaper therefore, and is the practice to "leave plenty on" to insure that the work shall "finish" all over when machined, otherwise the final corrections would occupy much more time than the actual formative work of the forging. But forgings which are stamped, all come out exactly alike from the dies, without any extra care or time spent on the part of the workman. Moreover, since the allowance left is small in amount and regular, pickling can be more usefully practiced than when allowances are excessive.



Machinery, N. Y.

Fig. 1. Die used for Correcting or Finishing End of Lever.

The accuracy of stampings, however, is further advantageous in the fact that a considerable amount of machining is often avoided altogether. The smooth, glossy, polished and accurate surfaces left from the dies are often good enough for handles, lever webs, and bossed parts. Or, if they are required to be bright for good appearance, then a polished surface imparted by an emery wheel and buff are sufficient, without any machining in the lathe, shaper, or milling machine. Punched holes may be simply lapped, instead of being drilled

* The following articles on this and kindred subjects have previously appeared in MACHINERY: The Manufacture of Dies and Drop Forgings, March, 1900; Making Drop Forging Dies, January, 1905.

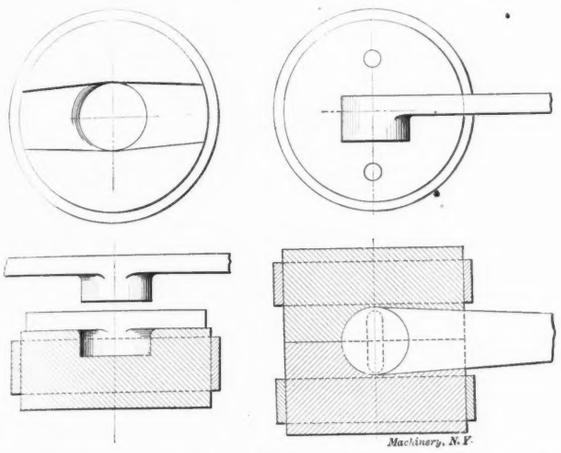
† Address: 45 Sydney Buildings, Bath, England.

‡ JOSEPH G. HORNER was born in Bristol, England, in 1847. His early technical training was acquired in serving an apprenticeship of seven years with Stothert & Pitt, Ltd., Bath, England, and by attending technical evening classes. After having finished his apprenticeship, he remained in the employ of Stothert & Pitt, where he worked, in all, considerably more than thirty years, of these, fifteen years as foreman. His training, gathered here, was most thorough, because the works, although now specializing chiefly in hoisting machinery, has, at different periods, handled many classes of manufacture. His duties as foreman kept him in close touch with all branches of mechanical work. For the last thirteen years he has been wholly occupied with technical literary work, and besides having contributed to a number of technical publications, including *Engineering*, the *Mechanical World*, the *American Machinist*, *Foundry*, *Cassier's Magazine*, etc., he was written a number of books, of which may be mentioned "Pattern Making," "Practical Iron Founding," "Toothed Gearing," "Helical Gears," "Plating and Boiler Making," "Dictionary of Engineering Terms," "Hoisting Machinery," "Tools for Engineers and Wood Workers," "Practical Metal Turning," "Milling Machines," "The Principles of Fittings," etc. He is also editor of the "Encyclopedia of Engineering."

and reamed, the locations of the holes being fixed with accuracy by the dies.

Development of Stamping Processes.

The history of die stamping goes back fifty years or more in the Black Country, and Birmingham district, England. In the blacksmith shops a limited amount of work had been done previously in dies for as long a period, but only or chiefly as a device for imparting a final finish to work which had been already prepared and nearly completed at the anvil. This practice arose out of the fact that only in this way was uniformity in a number of similar forgings economically possible. Such uniformity could only be produced on the



Figs. 2 and 3. Other Examples of Dies used for Finishing, but not for Rough Forging, Bossed Levers.

anvil with flatters and swages, at the sacrifice of much time and labor. Hence, long before the practice of *producing* forgings by stamping existed in the blacksmith shops, the practice had grown of *correcting* and *finishing* anvil-made forgings in dies under the power hammer. The dies were often of a sectional form, as they are still to-day when heavy forgings are in question. Thus, a die or pair of dies would include a boss only, on a lever, Figs. 1, 2 and 3; the lever ends standing out beyond the dies; or a die would be used to punch a hole, and correct the boss at the same time, Fig. 4. Lever ends, either forked or solid, are suitable objects for

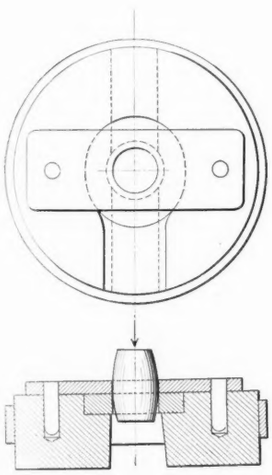


Fig. 4. Die used for Punching Hole through Boss, correcting Shape of Boss at the same Time.

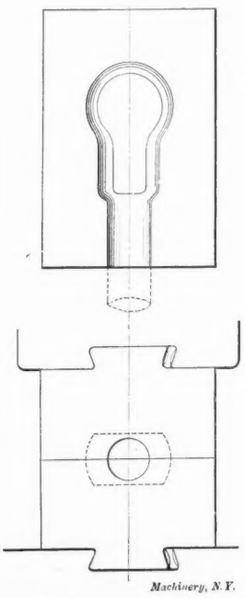


Fig. 5. Die for Finishing the End of a Connecting-rod.

finishing in this way. So are the ends of connecting-rods, Fig. 5, the eyes of the tie rods, and the bridles or loops of slide valves. In the old practice, as to a large extent now, these were made of wrought iron, bent, and welded. These operations were done at the anvil, and the correction and finish done at another heat in dies. These dies were and are made of cast iron from a pattern. Later, cast steel has been often used with a view either to increase the strength, or to lessen the weight.

Even on the anvil, in little shops where there was not as yet a steam hammer, the old Oliver was utilized in finishing the heads of bolts in dies, and the writer remembers seeing these

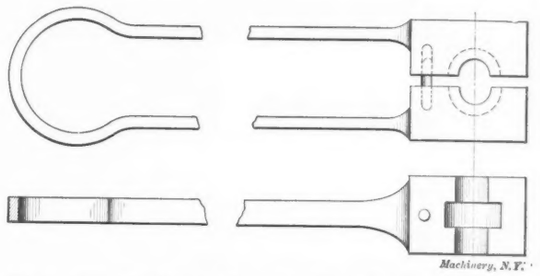


Fig. 6. Device for Shaping Bosses on Work, made on the Principle of the Spring Swage.

in operation. And on the anvil, little devices were rigged up for finishing bosses, and punching holes, the type of which was the spring swage, Fig. 6, the jaws of which were fashioned independently of aid from the machine shop, by a process of *typing*, or *hubbing*, from a dummy, or a duplicate forging. Very many simple forms can be and are done in this way still as a legitimate and suitable method. Light swages are used on the anvil, just as the heavier ones are operated under the steam or drop hammer.

The sectional dies are used very extensively now in the blacksmith shop for the purpose of final correction and finishing only. But along with the use of these, there has grown the practice of stamping wholly, either as a sub-department of the shop, or carried on in a distinct shop. Generally, however, the merely corrective dies are used for the

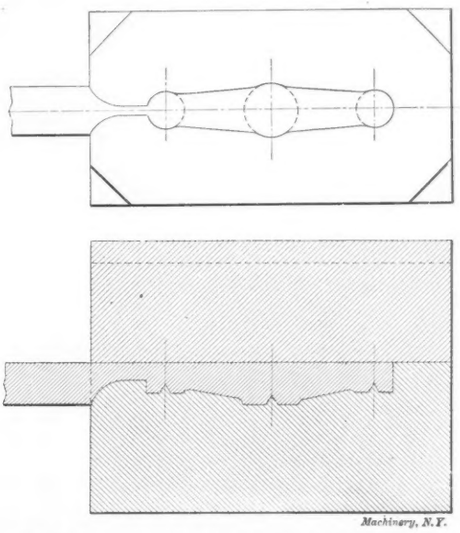


Fig. 7. Example of Forging Die, forming Center Holes in the Bosses of the Work.

heavier forgings, and the regular stamps for the smaller class, as in Figs. 7 to 10. To make the larger forgings entirely by stamping operations would often require heavier hammers and appliances than most shops are equipped with, and the numbers wanted of the large forgings might not be sufficient to render heavier installation remunerative. But a heavy forging may be corrected in dies when it would not be practicable to produce it entirely from a rude lump. Among work of this kind may be instanced large tie-rod eyes, large bossed levers, Figs. 1 and 2, rings, pillars, and such like. Some of these are too long to be embraced wholly in a single die. A long two- or three-bossed lever, for example, is then corrected only on its bosses, and for an inch or two away therefrom. A pillar for handrailing would have its bossed portions corrected separately, and the body corrected by swaging at the anvil, or in other dies.

Materials Used for Dies.

The number of similar castings required is often insufficient to justify a large outlay for cut steel dies. But dies made in cast iron are not costly, and therefore they are frequently made when only half a dozen or a dozen of similar articles are required. They may, of course, be kept for future use, and should be, when a job is likely to be repeated, but, apart from that, a very small number of forgings will pay the cost of cast dies.

The growth of stamping has been gradual and natural. The mere fact of having cast dies lying by from previous jobs

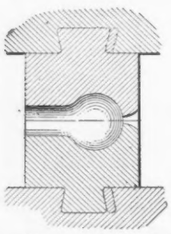


Fig. 8. Type of Die for Forming the End of a Ball Crank.

Fig. 9. Forging made in Dies from a Bar.

has been the cause of their utilization for pieces of work which might not otherwise have been thought to justify the expense of new dies. But being in stock, slight and unimportant alterations in some dimensions in new jobs would often render the dies available. In this way the beginnings of standardization arose. For as the dies began to accumulate, one pair or set was made to do duty for work for which it was not originally intended. Thus, the difference of half a ton or a ton of crane power was not allowed to involve the making of minute differences in the forged work for the cranes, but one standard set was used for both. So in engine and pump work the same standard sets came to be used for powers and sizes of mechanisms that were not very dis-

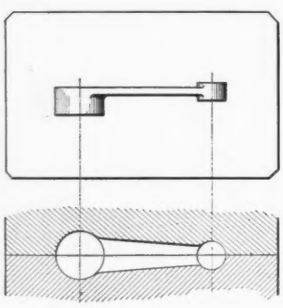


Fig. 10. Dies for a Lever with Hubs at Both Ends.

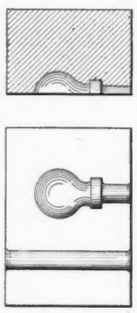


Fig. 11. Dies for Forging an Eye-bolt.

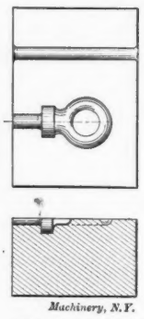


Fig. 12. Dies for Finishing the Eye-bolt.

similar, and when the difference of ⅛ inch, or so, in dimensions could make no possible difference in the proper operation or strength of the forged details.

Principles of Drop Forging and Stamping.

Comparatively few articles can be produced in one pair of dies, and those are chiefly circular forms, the diameters of which at different sections do not vary greatly. If they do vary, some preliminary reduction or "breaking down" is necessary. And if a portion of the article takes the form of an eye, or a boss, three or four successive operations may be necessary to produce the forging, as in the eye-bolt produced in Figs. 11 and 12. The die maker has then to settle how the work shall be done, whether in one or more pairs of dies, and whether under one hammer or two. As a rule, to which there are exceptions, it is desirable to do all the work at a single heat. Then, if several operations are required they must be done either in one set of dies, or in separate dies. For small forgings it is easy to get three or four recesses in one pair of dies, for roughing down, for formation, and for cutting off, or nicking for breaking off. In larger pieces it is necessary to have two hammers adjacent, so that the stamper can use them both without walking away from either. But a few hammers are made double headed, with two anvils, and tups to facilitate such work. When two heats are necessary, then it may be convenient to perform the earlier operations on a large number of similar pieces, and then change the dies for the subsequent work. This, perhaps, is more often done in the regular machine shops than in the stamping works, in which the work is divided between two adjacent hammers.

Though the smith working at the anvil endeavors to gage by a very rough mental estimation the amount of material

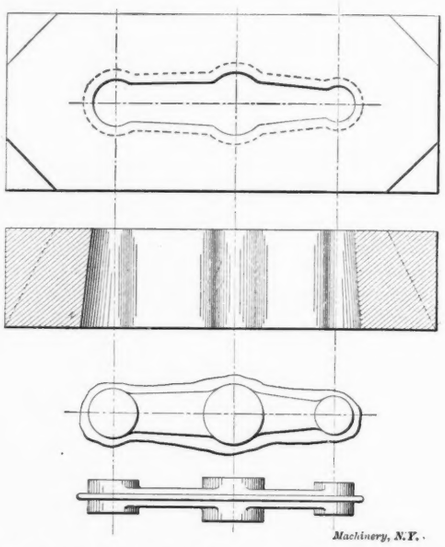
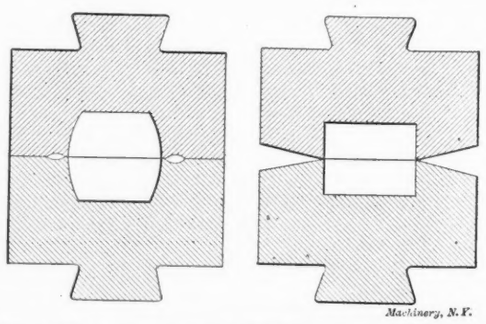


Fig. 13. Stripping Die for Removing Fin produced by Forging Process, and Work for which it is used.

which is required for a forging, in order to lessen labor, the stamper may be comparatively indifferent to that consideration. He will not, of course, have much excess of metal if it can be avoided, yet he is much in the same position as the anvil smith who has a steam or drop hammer available adjacent to the anvil. The power hammer is often resorted to for roughing down an odd lump quickly, in place of taking a smaller section, which would involve the alternative of upsetting, or of welding. The shapeless lump is simply roughed down rapidly in far less time than would be occupied in fullering on the anvil, or in performing the alternative operations of upsetting, or welding. In this way, too, very many odds and ends, cropped from iron or steel bars are utilized, which would otherwise go to swell the scrap heap.

The case of stamping is analogous. Though forgings having considerable differences in cross-sectional areas, are, as a general rule, broken down in one or more operations, preliminary

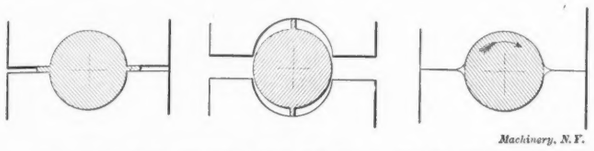


Figs. 14 and 15. Dies provided with Space for Receiving the Fin.

to finishing, yet a great deal of work is done without this step-by-step process. A cubical lump is taken and put into the dies and reduced. A large amount of fin being squeezed out in the process, this is removed in an adjacent stripping die, Fig. 13, and the forging put back, and finished in the first, or in another, recess, followed sometimes by a final stripping. This heavy reduction is only possible, first, because the lump is raised to a high temperature, and second, because the mechanical work done on it maintains the heat until the reduction is completed. At the anvil, two or three heats would often be required to accomplish the same amount of work which is done in one heat in stamps.

Removal of Fin Produced in Drop Forging.

The formation of fin, it will be noted, is peculiar to stamping; it does not occur in anvil work. Sometimes dies are cut like Figs. 14 and 15 to receive the fin. In Fig. 14 a wide and shallow groove is cut all around the recess to receive the fin. In Fig. 15 the faces are sloped away with the same object. Work which is of cylindrical form does not necessarily involve the formation of permanent fin, because it can be rotated, as the reduction is going on, and such excess of metal which is squeezed out laterally is removed at once when a partial rotation is given to the piece, as in Figs. 16 and 17. In Fig. 16 the fin is shown squeezed out; in Fig. 17 it is being driven into the forging again. Such being the case, Fig. 18 is the shape given to circular dies in cases where the circular form is not hampered by the proximity of shapes which would interfere with rotation. When the work can be rotated, the result is a fine, smooth, polished surface, which in many classes of work renders any subsequent machining unnecessary, or, if finish is essential, a little grinding may suffice. In some forgings a portion only, a stem or shank, can be so treated, the remainder consisting of an eye, or a flattened portion, or a square shape.



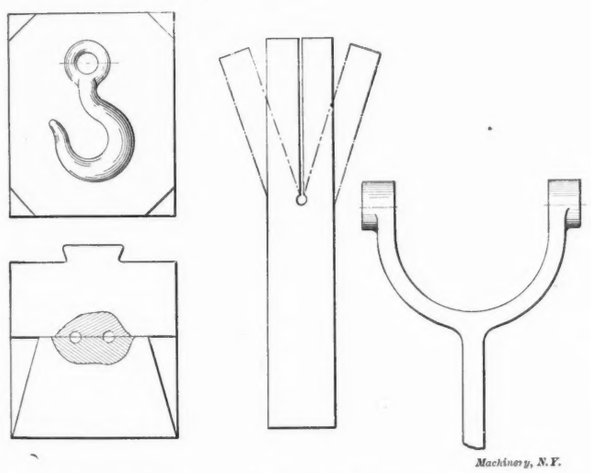
Machinery, N.Y.

Figs. 16 and 17. Showing how Fin produced on Round Work is forged into the Bar by rotating it.

Fig. 18. Die with Rounded Edges to receive Fin.

Difference between Treatment of Steel and Wrought Iron.

In the blacksmith shop, wrought iron is still used as extensively as steel for common forgings. But many forms when made of wrought iron must not be stamped from a solid lump because of the loss of strength which occurs across the grain. Large thin rings and curves of light section should always be bent. But if these are made of steel, no such reason exists, because steel has practically no difference in strength with or across the direction of rolling. The partial substitution of steel for wrought iron has therefore been favorable to the development of stamping. Many jobs are now stamped from a solid bar, or lump of steel, which were formerly made from wrought iron by bending and welding. Hence, while wrought iron is still extensively used for anvil-made forgings, steel is employed much more for stampings. The crane hook, Fig. 19, when made of wrought iron, is always bent from bar before being finished in the dies. Made from steel, it is stamped from a solid lump. For the forked end, Fig. 20, if made of wrought iron, a bar is slit, and opened out, and bent over a form, and finished in dies. When made of steel, it may be stamped from a solid mass. The flange, Fig. 21, is stamped in steel from a solid chunk, handled by a porter bar temporarily.



Machinery, N.Y.

Fig. 19. Dies for Crane Hook.

Fig. 20. Fork Lever, and Wrought Iron Bar from which it is made.

Work with Holes Forged through it.

The old method of punching holes is that shown in Fig. 4, in which the punch is guided by a plate doweled on the body of the die. This is suitable for large holes. Frequently, for small holes, the punch is separate, and driven through a hole in an upper die as in Fig. 22; in Fig. 23, a hole without its punch is shown. But punches are also often included solidly in the die, as in Fig. 26, half in top, and half in bottom, and not quite meeting at the center. In a shallow boss the punch may be in one half of the die only, as for a forging like Fig. 24. The metal becomes squeezed into the boss, and is improved by consolidation. Often, when holes are left to be drilled, the centers are stamped by small conical projections in the dies which serve as accurate guides to the driller. Sometimes holes are punched only through a portion of the metal, Fig. 25, when the central part has to be bored out subsequently, as indicated by the dotted lines.

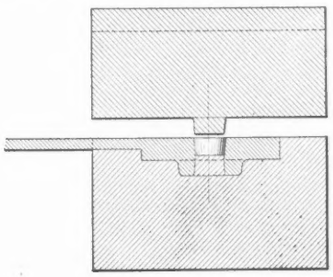
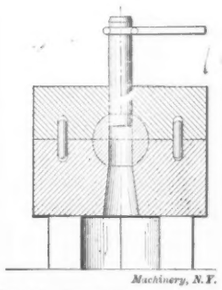


Fig. 21. Dies for a Circular Loose Hub.



Machinery, N.Y.

Fig. 22. Punching a Small Hole through the Work in the Dies.

Methods of Applying Impact or Pressure on Dies.

Formerly all die work was done with hammer blows. As the demand grew for an extension of the system to heavier forgings, and to articles involving the bending of plates and sheets, the steam and drop hammers were not able to deal so well with these. The demand was met by the presses, which are actuated by hydraulic power or by gears, cranks, and toggle levers. These will easily deal with dies and articles of several feet in length, many of which are too intricate to be dealt with by hammers, even if their dimensions did not set a limit to such treatment. They are practicable on the hydraulic presses, because two rams can be utilized, one acting in the vertical, the other in the horizontal direction, so working at right angles with each other. This is utilized for bending, welding, and punching, for closing up joints, for dealing with undercut designs, and with hollow spaces formed by bending and welding, or by stamping. Typical of much work of this class is the die and punch used for stamping the rings for uptakes of vertical boilers and the man-hole and mud-hole seatings for boilers, Fig. 27, from a plain piece of steel plate. Fig. 28 shows the dies for forging a crank by pressure. A large amount of work of this kind is done in the railway car shops.

Stamped forgings thus diverge into two great groups, according as they are produced by hammer blows, or by grad-

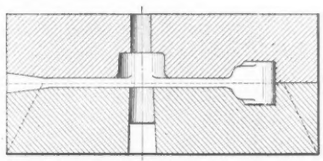
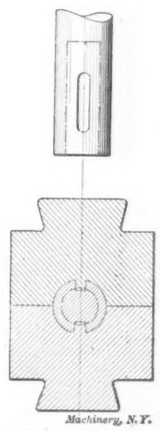


Fig. 23

Fig. 24



Machinery, N.Y.

Fig. 23. Dies for Punching Holes through Bosses. Fig. 24. Holes punched by Punches Integral with Die.

Fig. 25. Method of Forging the Slots in Collets.

ual pressure. Broadly, the first group includes articles of small and medium dimensions, the latter those of a massive character, and all large work done in plates. This is now a generally accepted division, and one which harmonizes with the difference in hammer blows delivered on comparatively small masses, and of pressure on thicker bodies. Where mass is the condition present, slow pressure is more penetrating than impact, just as it is in large shafts and forgings. Moreover, the blows delivered from a very heavy hammer are

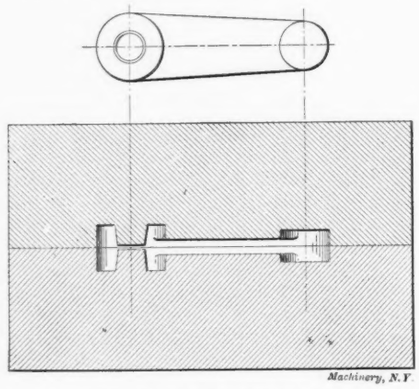


Fig. 26. Construction of Die for Forging a Hole through a Boss.

destructive to dies, and if they are made massive enough to withstand these blows, then they are too heavy for convenient handling. Massive dies are, of course, required to resist pressure, but that is not nearly so destructive as the violent, incessant jarring action of a hammer.

Methods Used for Making Dies.

The stamps or dies used are as varied in their details and cost as the forgings themselves are. A great advantage of stamping dies is, that like machine molding, they are as readily adaptable to the demands for a very few identical articles, say ten or a dozen, as to hundreds or thousands. But the amount of work put into the dies, and the patterns and the materials used for them have to bear a definite relation to the number of pieces required. Hence, we have at extremes, dies of cast iron made cheaply, and those of mild steel cut out with care and hardened. Except in name and function,

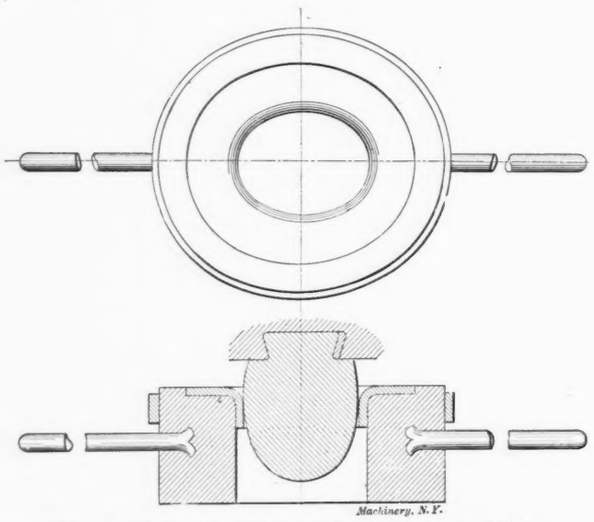


Fig. 27. Die used for Forging and Bending Man-hole Seatings.

the examples at each extreme have little in common. They are not made in the same way, and the periods of their service are much less in the first than in the second case.

The cast dies are molded from suitable patterns. They may have to be cleaned up a little by the machinist. As they are liable to fracture, unless made very massive, they are frequently encircled with bands of wrought iron, shrunk on, as in Figs. 1 and 4. They are, when small, lifted with circular tongs, Fig. 29, or by the hands, but larger dies have handles cast in for lifting them, Fig. 27. Or, alternatively, holes are cast in for the insertion of rods for the same purpose. Some cast dies will endure long service, others fracture soon. Dies of cast steel are stronger, but are more liable to inaccuracy.

Dies of forged steel are marked out on their faces, and recessed by various machine tools, and by hand work. All the aids afforded by machine tools are utilized, as boring, slotting, milling, and shaping. But often very much is left for the chisel and file to complete. There are several special machines designed wholly or chiefly for the use of die sinkers, but much can be done by the ordinary tools in the shops. Templets are used to check the progress of the work, including those of sheet metal for local sections, and those which represent the actual forgings which have to be stamped. These are made of lead, or tin, or a first sample forging is prepared. Contact is insured by the transference of red lead from the templet to the recesses which are being cut.

Reference has been made to the typing or hubbing process. It bears an essential resemblance to the operation of stamping medals and coins by a hard blow. Only the operation is reversed, the die itself being produced by stamping it, while white hot, from a cold forging. It has the advantage of being cheaper than cutting dies, and in circular outlines is accurate enough, but is not well adapted for intricate shapes. The spring swages are frequently made in this way. In

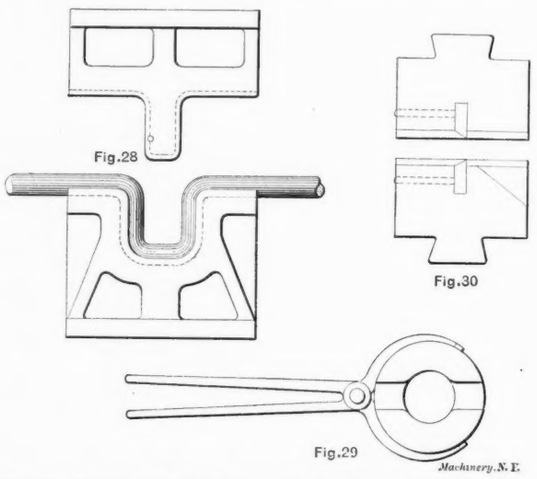


Fig. 28. Die for forging Crank. Fig. 29. Tong for Holding Dies.
Fig. 30. Cutters for Nicking the Stock, fitted at the End of the Dies.

obtaining circular shapes thus, the hub or type is rotated between each successive blow, so correcting any inaccuracies that might form. The edges are of necessity produced with a slight convexity, Fig. 18. But this is an advantage in producing circular forgings which are rotated in the dies. It is not necessary to have complete circles in such a case, because metal squeezed out laterally, and what would soon form a fin, becomes obliterated by the next blow when the rotation into a new position takes place.

In one of the illustrations, Fig. 3, dowels are shown, which are inserted to serve as guides to secure the alignment of top and bottom dies. These are only used when the dies are not attached in any way to the anvil below, and tup above, as is often the practice in heavy dies. But generally the dies are secured by dovetails and keys, as in Fig. 5. In some cases locating screws are used on the anvil for dies cut at the corners, like Figs. 13 and 19, and the dovetail is only on the tup. The locating screws permit of making slight adjustments.

Forgings are often included wholly in their dies, and are knocked out by a kicker device, or are pried out, or pushed out. Often a porter bar is used, generally the plain length of the bar from which the forgings are being stamped, as in Figs. 7 and 9. Then the forging is easily nicked off by reducing the eye at the neck, as shown in Figs. 7 and 9; or a pair of cutters is fitted at the end of the dies, as in Fig. 30.

The foregoing is an outline of the methods of stamping in use, from which it is seen that the practice is divisible into three great groups; that done under hammers, and that in presses, and a further subdivision between the methods of the general shops, and the drop forgers who work for the trade.

THE SETTING UP AND OPERATION OF THE POTTER & JOHNSTON AUTOMATIC CHUCKING MACHINE—2.

This installment completes the article relating to the setting up and operation of the Potter & Johnston automatic chucking machine. Owing to the frequent unavoidable refereneces to Figs. 1 to 7, it should be read in connection with the first installment, published in the April issue of MACHINERY.

As explained, the third turret face is empty, the cutting off of the collar being done during this portion of the cycle of operations. It has been taken for granted, of course, that in setting the turret slide for position, room has been left between it and the chuck for the cross slide. The cross slide is clamped in a convenient longitudinal position on the bed for the cutting-off operation, which will be done with a tool in the rear tool-post, so as to leave the front unobstructed for the operator. Where forming and cutting-off are to be done, forming is generally done at the front and cutting-off at the back, since heavier and more accurate forming work can be done with the work revolving downward toward a tool in the front tool-post, than with a tool at the back which is subjected to a lifting action.

The layout of the cross-slide cams is shown in Fig. 5. The rear feed cam is the one we have to use. Since this cutting-off operation is a short one, it may be done during the return of the turret for face No. 3. The cam drum is therefore rotated by hand until the turret for face No. 3 has begun to return. The cross-slide cams are loosened and the rear feed cam swung around to just touch the roller, the cross slide having been adjusted out to nearly the limit of its forward travel for cutting off, leaving approximately enough motion for cutting down the rear face of the collar and through the shell. The rear feed cam is then clamped in this position. A cutting-off tool is next placed in the rear tool-post at the proper height. The rear tool-post slide is adjusted to bring the point of the cutting-off tool up to the work, and the cam drum is revolved by hand until the piece is cut off. The cross-slide tool is, of course, set in the proper position to make a collar of the desired thickness.

Stopping the hand feeding when the roll is on the point of the cam, the cutting-off tool slide is permanently set on the cross slide so that the point of the cutting-off tool enters the bore just barely enough to completely sever the collar from the bushing. The motion of the cam drum is continued by hand until the roll is over the point of the feed cam. The cross slide is then pushed back by hand until the cam and roll are again in contact, when the rear return cam is brought up and clamped in position, so that there is just room for the roll between the feed cam and the return cam. The rear return cam, as the hand feed of the cam drum is continued, brings the cross slide back to its central position. Since there is no front tool used in the final layout of operations (Fig. 2 to the contrary, notwithstanding) the first feed and return cams are allowed to remain wherever they happen to be. These cam adjustments can all be made from the front of the machine.

Continuing the feeding of the turret slide, we next make sure that the cutting-off tool is returned to its normal position before the next face of the turret is presented for its operation, and then we proceed to set the recessing tool. This recessing tool, which is shown diagrammatically in Fig. 8, is a model of simplicity of design and action, as compared with the somewhat complex operation it has to perform. It may be said, in the first place, that this recess is for clearance only, and accurate dimensions and fine finish are not necessary. Assuming this, it will be seen that the operation of this recessing tool should be eminently satisfactory. The device consists simply of a slender boring-bar held in the turret, carrying a cutter suitably located about midway of the bar, the forward end of which is adapted to enter a bell-mouthed bushing held in the chuck. This boring-bar is bent to one side far enough so that the cutter clears the hole as the bar enters, but is forced into the work as the bell-mouth of the bushing engages the end of the bar and deflects it into its working position. The upper diagram shows the condition of the bar as it enters the hole, and the lower one its condition after it has entered the bushing and is engaged in turning the recess. This bar being properly designed as to its length, the position of the cutter with relation to the length of the recess in the work, and the location of the work with relation to the bell-mouthed bushing, it has merely to be set in the turret so that at the extreme forward travel of the turret slide the cutter is the same distance from the face of the chuck that the rear end of the completed recess will be when made to the desired dimensions. The cutter, of course, has been set out to give the recess the required diameter.

The final facing of the bushing by cam and turret face No. 5, so far as the setting of the tool is concerned, is merely a repetition of the facing operation on turret face and cam No. 1. This completes the setting of the cutting tools.

Making the Adjustments for Speeds, Feeds, Etc.

We have now to set the machine to perform automatically the desired changes of spindle speed, and fast and slow cam movements. Placing a new piece of work in the machine (the first one having been completed in the setting-up operations) the cam-shaft is revolved by hand until the turning tool in turret face No. 1 is just about to commence its cut. Hand-wheel *D* (Fig. 6) is now rotated in its normal direction until its next graduation marked "slow" is in line with the index mark on the base casting of the machine. Then the nearest pin *M* (see also Fig. 12) is moved up until it bears against

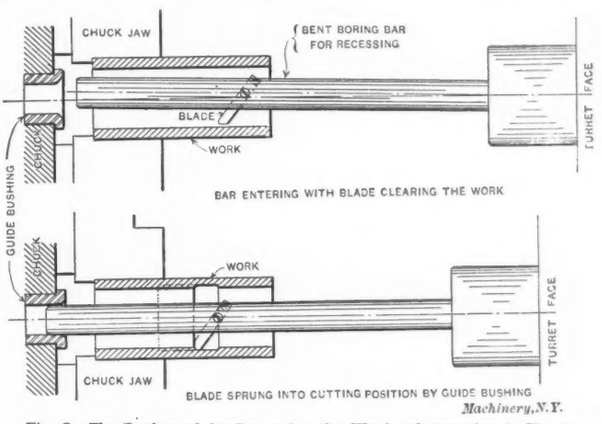


Fig. 8. The Tool used for Recessing the Work; shown also in Fig. 3.

the teeth of the star-wheel, when it is clamped in position. This should set it properly. To see if it is so set, return the cam-shaft by hand and throw in the automatic feed by moving lever *H* to the right, and watch the cut. The drum should slow down just before the tool commences to work. If it does not do this, the pin may be adjusted a little either way, as may be required. (In going over a piece for the first time, it is best to have the feed set to the smallest rate; that is to say, feed change handle *K* should be in position No. 1.)

After the cut has been completed and the turret feed cam roll is on the high point of the cam, the power feed may again be stopped, and the hand-wheel revolved until the next graduation mark "fast" is opposite the index mark. The next stop-pin is then moved up until it just touches the star-wheel, where it is clamped in position. The feed being again thrown in, the turret will be rapidly returned, indexed and moved forward for the second operation. Stopping the automatic movement, the pins are set for this face, and so on for all the operations, including that in which the cross slide is used for cutting off.

Operations 1, 2, and 3, being done on large diameters, should be done at the slow speed, handle *J* (Fig. 6) being set to give that speed. While, however, the turret slide is being returned between operations 3 and 4, one of the spindle speed changing dogs *N* should be clamped to the rim of disk *D* so as to change the spindle speed to the fast movement. This is continued until the last operation is completed, when a second dog of this kind is clamped in place to again throw in the slow movement.

The feed knock-off dog should also be clamped in place on the disk to stop the machine at the completion of the fifth operation, when the turret is in its rear position.

This completes the setting up of the machine. It is best for the operator to watch the operation the first time it is done automatically. If, as was the case with the parts shown, the feed is finer than is necessary, the feed change handle may be moved to the position which will give the greatest feed which it is possible to use with the work in hand. In the present case, as shown in Figs. 6 and 11, it was found possible to use No. 3. If at any time the tools show signs of distress, the feed may be lowered instantly by changing this handle; or if the work seems to be done without distress, it may be increased as easily.

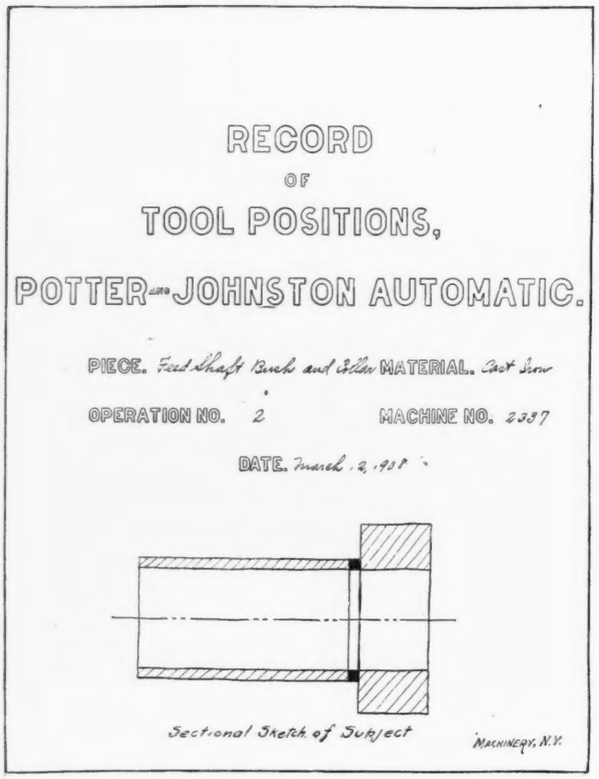


Fig. 9. The First Page of the Tool Record Sheet for Recording the Operations shown in Figs. 2 and 3.

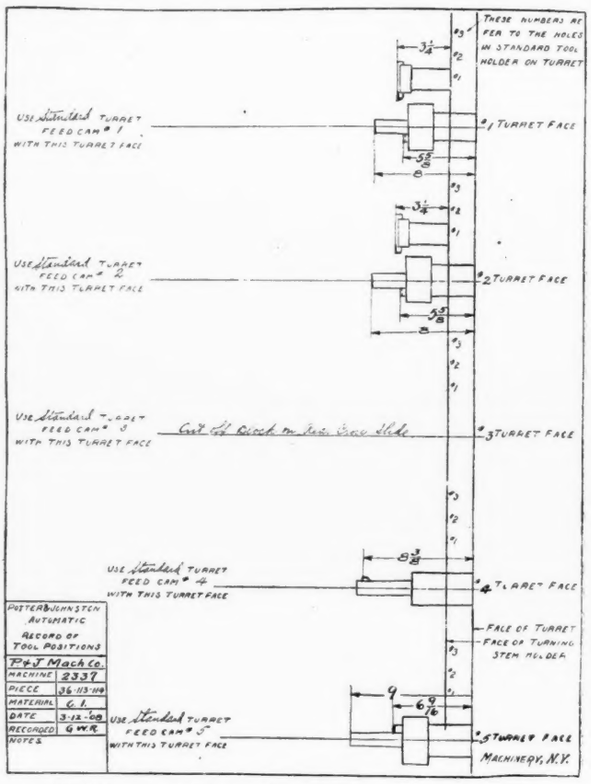

THESE NUMBERS REFER TO THE HOLES IN STANDARD TOOL HOLDER ON TURRET
Use Standard TURRET FEED CAM No. 1 WITH THIS TURRET FACE
1 TURRET FACE
Use Standard TURRET FEED CAM No. 2 WITH THIS TURRET FACE
2 TURRET FACE
Use Standard T-BOLT FEED CAM No. 3 WITH THIS TURRET FACE
Cast Iron Block on Cross Slide
3 TURRET FACE
Use Standard TURRET FEED CAM No. 4 WITH THIS TURRET FACE
4 TURRET FACE
FACE OF TURRET
FACE OF TURNING STEM HOLDER
Use Standard TURRET FEED CAM No. 5 WITH THIS TURRET FACE
5 TURRET FACE
POTTER & JOHNSTON AUTOMATIC RECORD OF TOOL POSITIONS
P & J Mach Co.
MACHINE 2337
PIECE 36-113-109
MATERIAL C.I.
DATE 3-12-'08
RECORDED G.W.R.
NOTES
MACHINERY, N.Y.

Fig. 10. Second Page of Tool Record, giving the Setting of Cutting Blades.

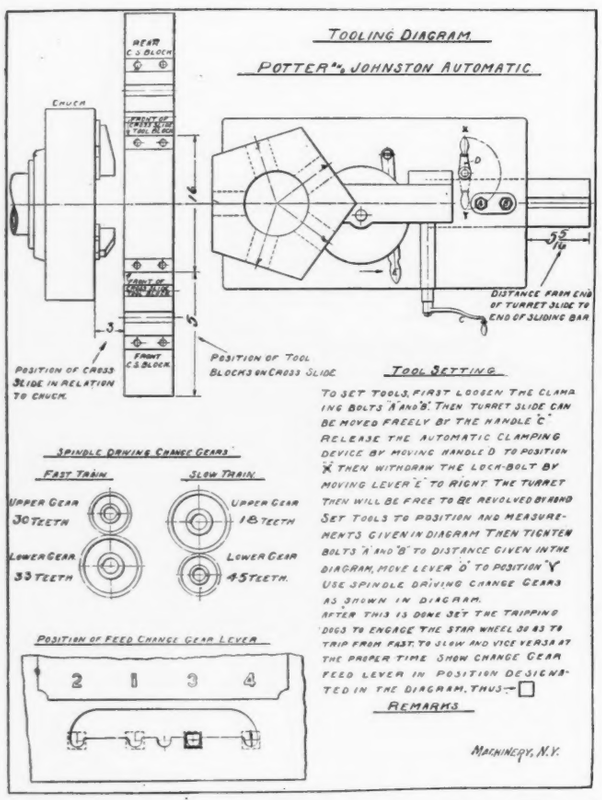

TOOLING DIAGRAM
POTTER & JOHNSTON AUTOMATIC
REAR C.S. BLOCK
CHUCK
FRONT C.S. BLOCK
DISTANCE FROM END OF TURRET SLIDE TO END OF SLIDING BAR
POSITION OF CROSS SLIDE IN RELATION TO CHUCK
POSITION OF TOOL BLOCKS ON CROSS SLIDE
SPINDLE DRIVING CHANGE GEARS
FAST TRAIN
SLOW TRAIN
UPPER GEAR 30 TEETH
LOWER GEAR 33 TEETH
UPPER GEAR 18 TEETH
LOWER GEAR 45 TEETH
POSITION OF FEED CHANGE GEAR LEVER
TOOL SETTING
TO SET TOOLS, FIRST LOOSEN THE CLAMPING BOLTS 'A' AND 'B'. THEN TURRET SLIDE CAN BE MOVED FREELY BY THE HANDLE 'C'. RELEASE THE AUTOMATIC CLAMPING DEVICE BY MOVING HANDLE 'D' TO POSITION 'X' THEN WITHDRAW THE LOCK-BOLT BY MOVING LEVER 'E' TO RIGHT. THE TURRET THEN WILL BE FREE TO BE REVOLVED BY HAND. SET TOOLS TO POSITION AND MEASUREMENTS GIVEN IN DIAGRAM. THEN TIGHTEN BOLTS 'A' AND 'B' TO DISTANCE GIVEN IN THE DIAGRAM, MOVE LEVER 'D' TO POSITION 'Y'. USE SPINDLE DRIVING CHANGE GEARS AS SHOWN IN DIAGRAM. AFTER THIS IS DONE SET THE TRIPPING DOGS TO ENGAGE THE STAR WHEEL SO AS TO TRIP FROM FAST TO SLOW AND VICE VERSA AT THE PROPER TIME. SHOW CHANGE GEAR FEED LEVER IN POSITION DESIGNATED IN THE DIAGRAM, THUS →
REMARKS
MACHINERY, N.Y.

Fig. 11. Third Page of Record, showing the Setting of Turret Slide and Cross-slide Tool-blocks, and the Setting of the Gearing for Spindle Speeds and Feeds.

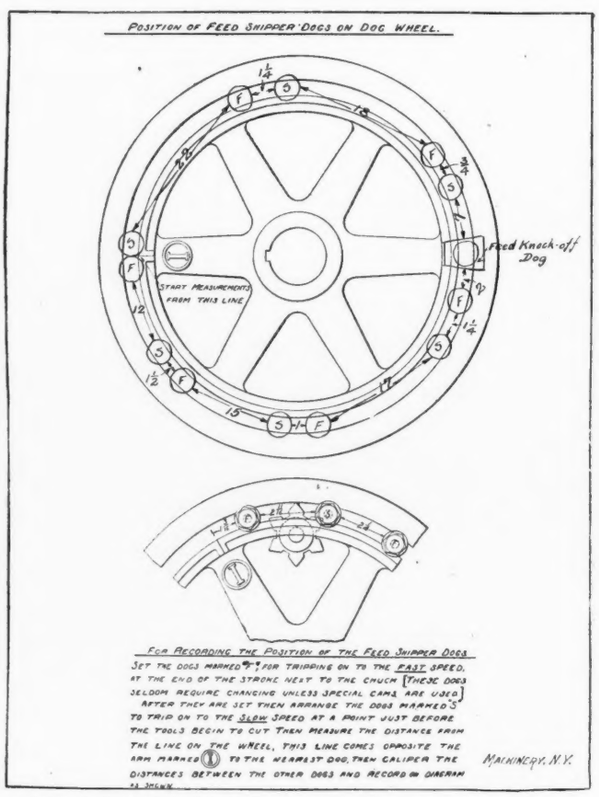

POSITION OF FEED SHIPPER DOGS ON DOG WHEEL.
Feed Knock-off Dog
START MEASUREMENTS FROM THIS LINE
FOR RECORDING THE POSITION OF THE FEED SHIPPER DOGS
MACHINERY, N.Y.

Fig. 12. Fourth Page of the Record, giving Setting of the Feed Shipper Pins and the Feed Knock-off Dog.

It has taken some little time to describe the setting up of the machines for this simple operation. In reality, however, in the hands of a competent operator, the setting up takes

little, if any, more time than the setting of a single piece in the lathe. There are no more tool settings to make than with the ordinary type of turret lathe, and the extra changes, such as the setting of the pins and dogs for the speed and feed changes, are made so quickly as to consume little time in comparison with the cutting movements. With the exception of the recessing tool, which is of simple construction, all the tools are a part of the regular equipment of the machine.

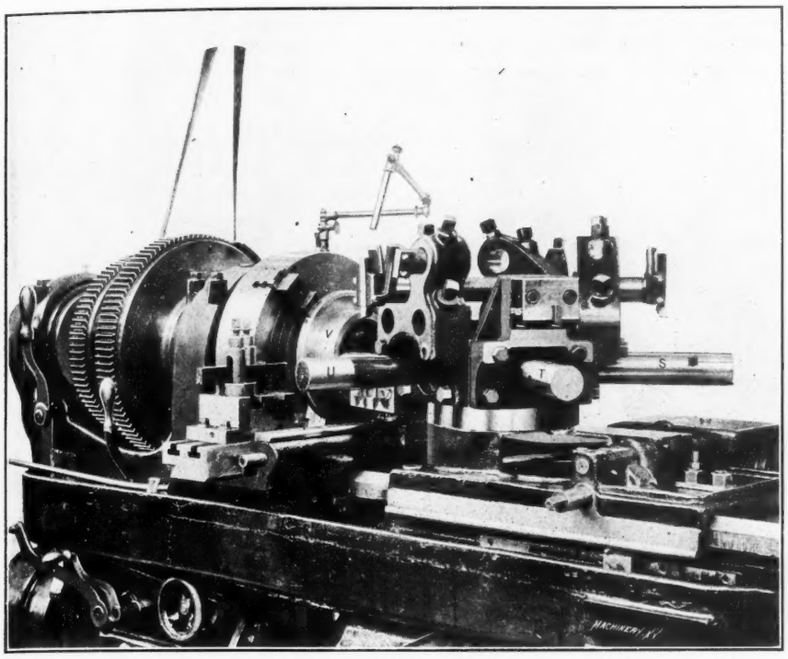


Fig. 13. Front View of Machine engaged in Finishing a Flanged Sleeve, made from a Steel Casting.

Tool Record Sheet.

The builders of this machine furnish a convenient form for recording the settings of a piece of work after they have once been obtained. We show the four pages of one of these records in Figs. 9, 10, 11, and 12, made out for the piece whose machining we have just described. It is printed in ink resembling India ink, in which the blanks are filled out by hand. The first page, as shown, gives the name of the piece, the material and the number of operations performed—this being a second operation, as previously explained. The number of the machine is also given for convenience in identifying it with the following operations. The fact that the part is cut in two to make two pieces of work, is plainly shown in the sketch.

The second page is taken up with sketches of the various tool-holders and cutting tools used. The distance of each of the cutting edges from the face of the turret or the face of the tool-holder is given. The tool-holder may thus be set at once without going through the trial settings we have mentioned as being necessary the first time the work is done. Tools held in the standard tool-holder have their distances measured from the face of the holder, while tools held in the face of the turret have their cutting edges located by the turret face. The feed cam used for each of the operations is also indicated. In recording work on which special cams might have to be used, the number of the cam employed for a given operation would be indicated in place of the word "standard," which we have for all five operations in this case.

On the third page of the pamphlet are shown diagrams giving the measurements for the setting of the cross slide longitudinally of the bed with relation to the chuck, and for the setting of the turret slide with relation to the cam roll. The latter measurement is taken, as indicated, from the end of the turret slide to the end of the sliding bar. The setting of the cross-slide blocks and cross slide is also given. The change gears for the fast and slow trains are recorded as shown, as well as the position of the feed change gear lever which was found the most suitable for the work. General instructions for tool setting are also given.

The last page of the record is occupied by a diagram in which the settings of the feed shipper pins are noted. These settings are obtained by using inside calipers in measuring the distance between consecutive pins. These distances, after being recorded, may be used in again setting pins for new work, thus making unnecessary the trial operations we have described. In actual practice, however, with competent workmen, this page of the record is not ordinarily filled out, it being as simple a matter to set the pins by trial as to measure them. For workmen not used to the machine, however, this record will be found very helpful. Regular use of the other features of these records will be found to save considerable time on work which has to be done repeatedly.

The Tools and Operations for a More Complicated Job.

The operations we have just shown are comparatively simple. In Figs. 13 and 14 are shown front and rear views of another machine in operation at the time of the writer's visit, in which many more tools are used, and in which much greater accuracy is required.

The machine is of the same type as the one shown in Figs. 1, 2, and 3, though of a somewhat older design. The part being machined is made from a steel casting. It is intended to be a sleeve for use in holding bushings in the chucks of the automatic machine for guiding the pilot bars of tools held in the turret. The face of the chuck which carries the

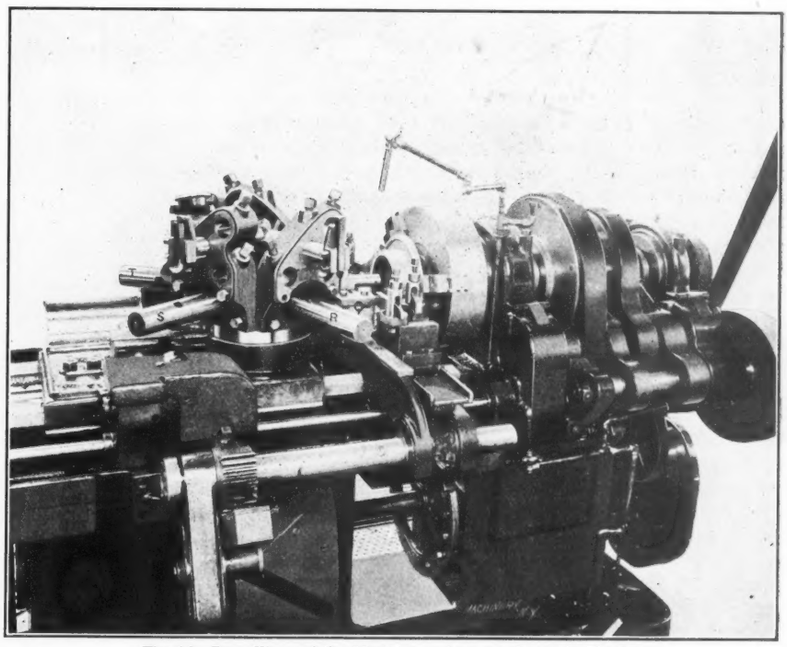


Fig. 14. Rear View of the Machine, set up as shown in Fig. 13.

sleeve is recessed, like the one shown in Figs. 13 and 14 holding the work, though a smaller sized sleeve would be used with that chuck. The lip on the flange of the sleeve enters this recess, in which it must be carefully fitted. The body of the sleeve is also very carefully fitted to the bore of the chuck. It will be seen that this sleeve ties the sections of the chuck together, so that on large, heavy work the clamp-

ing of the jaws down on the work will not spring the body of the chuck so as to distort it, and cause the pilot bushing within the sleeve to run out of true.

The first operation is performed by the turret face shown at *U*. It consists in rounding the corner of the large diameter of the flange, rough turning the outside diameter of the body, and facing the outer end of the body. This operation, like all the others, is steadied by the pilot bar shown, which is supported by a bushing in the chuck. The tool for facing the end of the body is not plainly shown in the engraving. The second operation, on turret face *T*, recesses the flange to form the lip, using a facing tool held in a special tool-holder, as shown. The third operation on face *S* finish turns the outside diameter of the body. The fourth operation, on turret face *U*, finish turns the inner side of the lip to the exact diameter desired. In the last operation, the hole is bored by a taper attachment *Q*, as will be explained, and the lip is finish faced by a tool held in the cross slide.

The bore of the sleeve is tapered, and one of the most interesting of the tools is that used in the final operation for boring this taper. It is shown in action in the two views of the machine given, but is best seen in Fig. 14. It consists simply of a cross slide carried by the turret, and provided

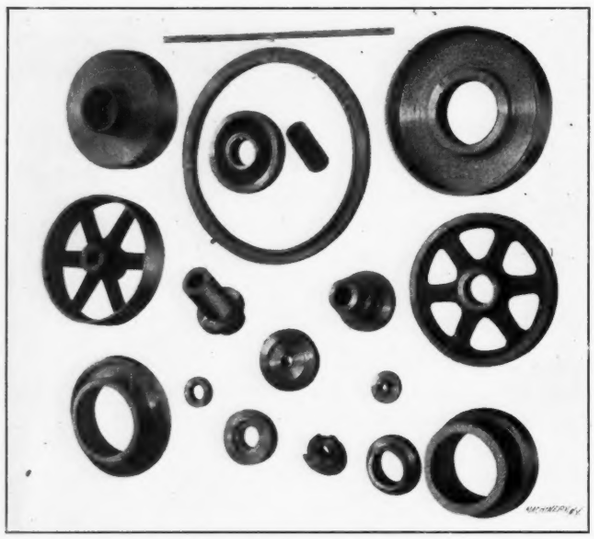


Fig. 15. Group of Parts, showing the Variety in a Typical Day's Work, as done on the Machines in the Builders' Shops.

with a spring which tends to keep it forced toward a stop at the rear end of its travel. In the T-slots of the cross slide on the back end is clamped a hardened plate *Q*, with a ground straight-edge which is set to the desired taper. The end of a tool in the tool-post held in the rear cross-slide block is brought up against the edge of this plate by the cross-slide cam. The cross slide remains in this position throughout the operation. During the forward feeding of the turret, the action of the shank of this tool on the tapered plate forces the cross slide toward the front slowly, in such a way as to reproduce the taper of the plate in the bore of the hole. This simple arrangement produces tapers of a high grade of accuracy, as revealed by the usual test of finding the bearing in the hole produced, of the standard taper plug to which it has to be fitted.

The operation on this part takes something like three-quarters of an hour to perform, as compared with the very few minutes required for machining the bushing and collar shown in the first series of operations.

Range of Work for which the Machine is Fitted.

The wide range of work for which the machine is suited may be realized by referring to Fig. 15, which shows the work being done on the machines at the time of the writer's visit. The two upper parts at the right and left are cast iron, being clutch bodies for the spindle clutches of the chucking machines. The large cast iron ring shown is of a diameter that nearly taxes the machine to the limit of its swing. Inside the ring are shown a cast iron gear blank and the recessed bushing whose making we have described. The collar of this bushing is shown near the bottom of the group. The steel sleeve whose making is shown in Figs. 13 and 14 is at the lower left-hand corner of the group. A bevel gear blank and a cam are also shown, as well as a pulley and several miscellaneous pieces.

This group gives a favorable idea of the variety of the work possible on the machine, but it does not include any bar work or any work on composition metals, like brass and bronze, for both of which the machine is successfully used. For brass and bronze, the spindle is usually driven directly, instead of through gearing, to give the higher rotative speeds required.

Among the operations possible on the machine by the use of tools which have not been described, may be mentioned tapping, for instance, which may be done either right- or left-hand without reversing the spindle. Another device with which the machine may be provided is the "back facing" attachment, which is operated from a separate cam, applied to the cam-shaft, acting through levers on a back facing bar, which passes through a hole in the spindle, in a position to act on the rear face of the work inside the chuck jaws. In this may be mounted drills, cutters, facing tools, etc. Where extreme accuracy is required, a double back facing attachment may be used, arranged with cutters for taking both roughing and finishing cuts. A large proportion of the machines sent out by the builders are fitted with this attachment, whose use, in the general run of chucking work, will usually save a second operation.

Bar work up to 6 inches in diameter is also handled to good advantage, floor stands being provided for supporting the outer end. For bar work, as well as for steel castings and forgings, in which the holes are not cored, an oiling arrangement is provided for the turret, which forces the oil through the drill under heavy pressure to the cutting point. The oil flows only through the hole in the turret, which may be at the moment presented to the work.

Other such special arrangements as cam turning devices, two-position chucks, etc., will be provided as may be required by the purchaser. A large field of complicated operations is opened up by employing these, many of the combinations possible being of great ingenuity. The builders have developed a thriving business in the design of special tools for special operations. The possibilities of the machine with regular equipment, however, are evidently very great in the ordinary run of machine shop work.

It is not unusual to see as many as ten cutting tools in simultaneous operation on a piece, being carried by the turret, cross slide, and back facing holder. When such a tooling arrangement can be employed, it will be understood that the machine will show a saving over the ordinary type of hand lathe.

* * *

An interesting method for reproducing drawings, maps, etc., is mentioned in *Teknisk Tidskrift*. This method is termed "helios printing," and by the use of this method it is possible to take copies from drawings on any kind of white drawing paper, if the lines are simply drawn heavy enough so as to give resistance to the light. Not only is it possible to make copies from drawings on any kind of paper, but it is also possible to reproduce these copies on any kind of paper, as for instance, on tracing paper, white Whatman paper, ordinary yellow drawing paper, tracing cloth, etc. It appears that a great number of copies can be produced in a very short time. The method by means of which the work is carried out, however, is kept secret by the concern in Stockholm, Sweden, which makes a business of printing from other firms' drawings. It is stated that the price charged at the present time is about 20 cents a square yard for copies reproduced on good white paper, when several copies are ordered from the same drawing.

* * *

In the course of a lecture on the drive of machine tools, presented before the Pomeranian section of the Society of German Engineers, it was mentioned that for high speed cutting steel the proper cutting speed for cast iron is 66 feet; for machine steel 82 feet; for tool steel and steel castings 59 feet, and for nickel steel from 10 to 33 feet.

MONNET & MOYNE MACHINE FOR BENDING TUBING.

In bending a tube by the usual process, it is filled with sand or some similar substance, after which the ends are capped to hold the material in place; the bending is then performed by any suitable means, generally around forms of suitable radius to give the desired curve. The filling with sand is done to prevent buckling or flattening of the tube while it is being bent. The fact that the ends of the pipe are capped, maintains the pressure of the sand, and prevents such decrease of the interior volume as is necessary for flattening or buckling.

Messrs. Monnet & Moyne, of 11 Rue Torricelli, Paris, have recently perfected a machine for bending tubing which performs the operation satisfactorily without flattening, buckling or other deformation of the work, and without requiring the usual filling with sand. This interesting machine we show in diagrammatic form in the accompanying line engraving. Fig. 1 shows a vertical section through the column of one of the smaller machines. Fig. 2 shows a plan view of the top of the machine and Fig. 3 shows the operation in progress. The same reference letters apply to each of the three diagrams.

To the top of the column is clamped a bracket *A*, carrying at its outer end a fixed pivot *B*, and provided with a slide and adjusting and clamping screws for locating a second pivot *C*, at any desired distance from pivot *B*. Pivot *C* carries a rectangular block *D*, having semi-cylindrical grooves in its face, made to the radius of the pipe it is desired to bend. Above and below it, about the same pivot, are mounted bars *E*, which extend out to the side of the machine, where they are pivoted to a brace *F*, which is clamped in a swivel *G* at the top of the column of the machine.

Pivot *B* has mounted on it a former *H*, provided with a lever *J* for swinging it about its center in the forming operation. This former is turned to the radius to which it is desired to bend the tubing, the groove provided being of a circular section to match the diameter of the work. Attached to *H* is a clamp *K*, formed of a stirrup and thumb-screw,

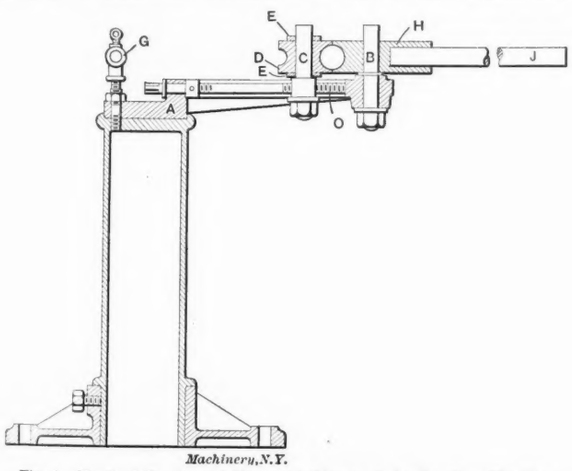


Fig. 1. Vertical Section of Monnet & Moyne Tube Bending Machine.

which clamp together serrated jaws, adapted to firmly hold the pipe and apply the pressure to it from all sides, so that it is not deformed. At the outer end of the frame-work (formed by bars *E* and brace *F*) is a support *L* for a bolt *M*, which is threaded into the right-hand end of the mandrel *N*.

In the peculiar construction of mandrel *N* lies the novelty of this bending process. As may be seen in Figs. 2 and 3, it has a solid body, but its left-hand end is composed of three articulated sections, forming a flexible extension of the full diameter of the hole in the pipe, so joined together as to be able to follow a curve of the shortest radius to which the tube can be bent. This is most plainly shown in Fig. 3.

The method of operation is as follows: The interior of the tube *P* is first cleaned with a wire brush. The tube is next placed in the groove of former *H*, and gripped tightly in the jaws of the holding clamp *K*. Mandrel *N* is next oiled and inserted inside of the tube, its position being so adjusted by the nut at the end of bolt *M* that the extremity of the solid body of the mandrel lines up with axis *X Y* of former *H*, as shown in Fig. 2. Guide block *D* is next adjusted by

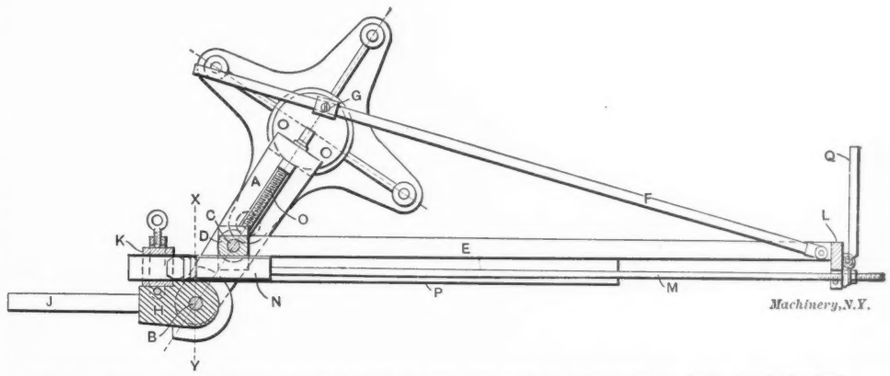


Fig. 2. Plan View of Machine, showing Forming Dies and Method of Holding the Articulated Mandrel.

means of a screw *O* to such a position that the distance from its face to the axis *X Y*, when it is brought in contact with the work, is equal to the diameter of the tube. This being done, pivot *C* and screw *G* are tightened, rigidly securing the framework formed by base *A* and members *E* and *F*.

The tube is now bent to the angle required, by operating handle *J*, which may be lengthened, as required, by the use of a piece of pipe of suitable diameter. When the tube has been bent to the required angle, the mandrel is withdrawn, being started by pressing on lever *Q*, after which it may be easily removed. The vise *K* is then loosened and the jaws removed, when the work can be taken out of the machine. The position of the mandrel during the bending is shown in Fig. 3.

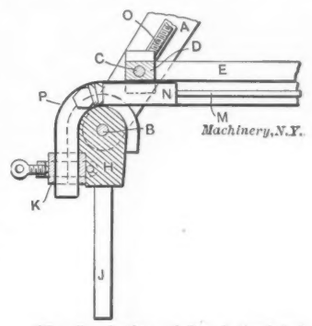


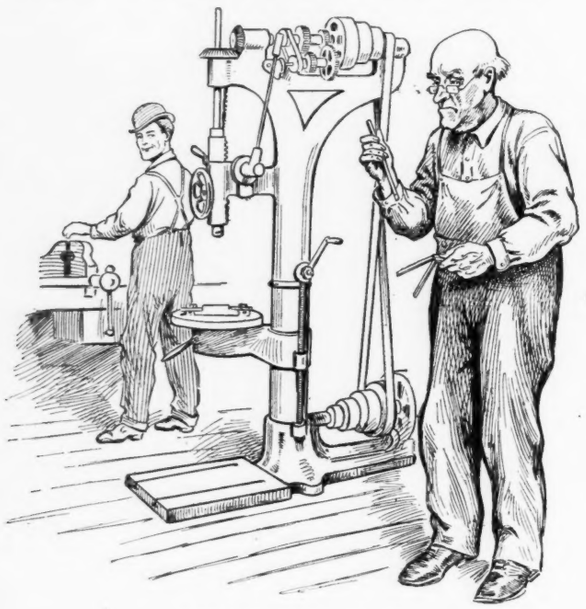
Fig. 3. Action of the Articulated Supporting Mandrel during the Bending Operation.

After the device has once been set up, it is only necessary to brush out the tube, clamp it into place, oil and insert the mandrel, and oil the guide, after which the work is bent and removed as previously described. Two operations per minute are easily possible on work of medium size. This, it will be seen, is a great saving over the old method in which it was required that the tube be filled with sand previous to bending. Even very thin tubes may be curved with this device, since the flexible mandrel prevents all possibility of the collapsing of the walls. The action is that of a drawing out of the fibers on the outside radius of the curve, combined, possibly, with a slight compression of those on the other side. Owing to the flow of metal which takes place, the material is hardened appreciably, thus increasing its resistance to deformation.

Different formers *H* are required for different radii of curvature and for different diameters of pipe. Special formers have sometimes to be provided for tubes curved in two places. Guide *D* may be used on all radii of curvature within the range of the machine, but must be changed for different diameters of pipe. The machine is made in five sizes, for the following maximum diameters: ¾, 1½, 2⅜, 4 and 6 inches, respectively. The smaller sizes are hand operated, as is the case with the 1½-inch machine, of which we show diagrams. Larger sizes are operated by power. This machine is said to have found extensive application in automobile, boiler and railway shops in England and on the Continent.

HOW BILLY CAME TO USE TWIST DRILLS.

It was mighty difficult for old Billy Brown to give up his belief that a well forged and ground flat drill was not superior to a twist drill. He had been using flat drills for 40 or 50 years, beginning, in fact, long before the twist drills were originated, and when the younger hands came up and began to talk to him about some improvements of this or that kind, Billy Brown would smile in a superior way and explain to them that he was experienced in the business long before they were born. In particular, the flat drill was one of Billy Brown's hobbies, and unless the force of circumstances prevailed, he would never consent to use a fluted twist drill. Billy had been working in this same shop for so many years that he had become something of an old inventory, and the boss did not care much about Billy's queer ideas, particularly as he was a pretty good tool-maker, notwithstanding his opposition to new wrinkles. Billy's favorite boast was that no one in the whole shop could grind a flat drill just as he did it, as none of the others had the experience, because of using



"What ails the d—— thing?"

these new-fangled drills. Billy's boasting finally led to his downfall, and as usual a shop "kid" was the cause.

It happened one day that Billy was going to drill a ¼-inch hole on the upright drill press, and while he was grinding his drill, young Jimmy Smith went up to Billy's machine and crossed the driving belt. Billy put his drill into the socket and started off drilling, but, to his dismay, he found that his drill would not cut. The reverse motion of the drill spindle was not very apparent, because of its high speed, and then, too, Billy's eyesight was not as good as it was once. He hardened his drill again, and ground it very carefully, put it in the drill press, and still it would not work. A thing like this had never happened to Billy before, and he began to worry about not being able to grind a flat drill so that it would cut. So sudden was the loss of a boasted ability that Billy might well be pardoned for getting a little flustered.

He finally hardened his drill for another trial, and ground it even more carefully than before to the angles that had never failed him before, but strange to say the drill still would not make any impression whatever on the piece of work. Then he tried the work with a file to see whether it was not hardened, but it was nothing but ordinary soft machine steel. Then he tried the drill with his file and found that it was just as hard as it could be, so the fault evidently must be with the grinding of the drill. Then Billy totally lost confidence in himself, and went up to one of the younger men, explaining to him his troubles. Jimmy, the innocent, who was always around when he was not wanted, came up and looked at Billy's drill, and said: "Why, Billy, of course that drill wouldn't cut. Don't you see you haven't ground to the right angles at all?"

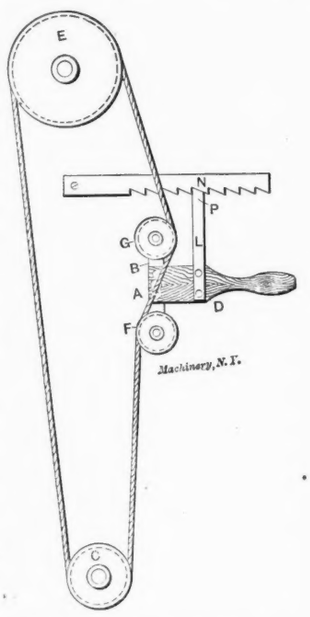
I won't try to repeat what Billy said to the apprentice, for that would not look good in print, but Jimmy, unabashed, snatched the drill from Billy and ran over to the grindstone, pretending that he was grinding the drill to its proper angles, while, of course, he left the cutting surfaces undisturbed. During this grinding operation, however, somebody kindly put the belt right again on the drill press, and Jimmy, placing the drill in the socket, fed it down and it cut through the piece of work as though it were butter. Billy stood dumbfounded, and that noon, he went up to the foreman and said: "I guess I am getting too old to work in the shop." The foreman, however, who by this time had heard the story of Billy's trouble with the drill, persuaded Billy that he could not spare him, and Billy, greatly gratified to hear that, concluded that thereafter he would use a twist drill, and now Billy thinks that twist drills are far superior to the old flat drills.

I often think of Billy and his flat drill hobby. We laugh at him and his ignorance or perversity, but aren't most of us about as foolish on some pet notion? We often need a jolt to knock out old delusions, so that new ideas can get in. Billy got a hard one, but the old man, after all, was more sensible than lots of young men would be.

* * *

A BELT TIGHTENER.

An interesting tightener for a small belt or rope drive is shown in the *Practical Engineer*. It often happens that it is desirable to arrange one or more machines, so that they can be conveniently stopped and started, without reference to the running of the rest of the machinery. Of course, this problem is usually solved with friction clutches, loose pulleys, etc., but there sometimes occur cases where a pulley is driven directly from the line shaft and there is no room to put in any of these extra appliances.



In a problem of this kind, where it is desired to arrange a drive for the machine so that it could be stopped and started at any time, the arrangement shown in the accompanying illustration was devised. In the cut, *C* is the driving and *E* is the driven pulley. The pulley *E* may be started and stopped by means of the twin idlers *F* and *G*, which are mounted on a bar of iron, *B*, of suitable size, the pulleys running on studs, screwed into this bar. The bar *B*, in turn, is fastened to a wooden piece *D*, which, with the bar *B* is pivoted on a suitable stud at *A*. Thus it will be seen, that when the handle on the end of *D* is pressed down, it will tighten the belt without a very great swing of the idlers, and when the handle is lifted it will release the belt and allow it to hang free from the bottom pulley *C*. The belt is held at proper tension by means of the locking device shown, consisting of the iron bar *L*, attached to the block *D*, the upper end *P* of which engages in suitable notches in bar *N*, and holds the idler frame wherever set. This locking device is conveniently released by simply raising up bar *N*. It is evident of course that on a large belt, a certain amount of power is wasted by this arrangement, and it may not be advisable to use with large belts.

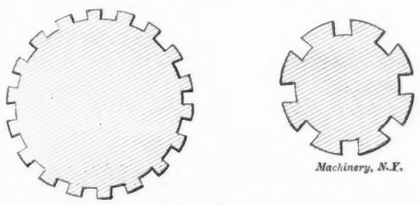
* * *

In almost every shop and factory in the country, men and women are just aching to be interested in the firm's welfare, if the employers would only let them. Any man or woman would rather be interested in his work than not be, for when the heart is in it, work is easy, and easy work is work done right.—*The Silent Partner.*

ITEMS OF MECHANICAL INTEREST.

GROOVED SHAFTS FOR MOTOR CARS.

The Lanchester Motor Co., Ltd., of Birmingham, England, employs a rather interesting means of securing driving parts of automobiles to their respective shafts. The principle employed is clearly illustrated by the two sections of shafts shown in the accompanying cut. The shafts are grooved as indicated, and the corresponding female parts are provided with grooves to fit. This system of connecting the shafts with the rotating parts was adopted by this company over eight years ago, and has stood the test of long time of service. In

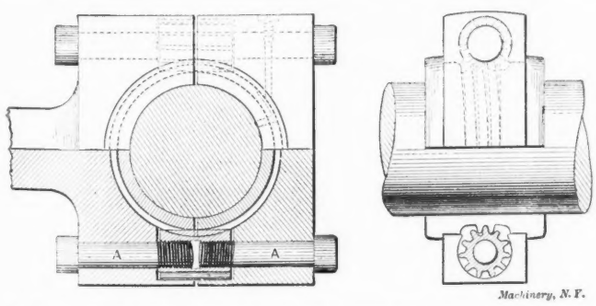


Grooved Motor Car Shafts over which Hubs with Corresponding Grooves Fit.

the first place, the use of this kind of shaft was restricted to cases where keys were awkward or difficult to arrange, but the results proved so satisfactory that in the modern Lanchester car this system of connecting shafts and rotating parts has been adopted almost exclusively for all cases where there was any reasonable gain from having the shaft and the rotating parts so firmly connected, and the system has also been adopted by several other British motor car firms. It would appear, on first sight, that this kind of joint would be rather expensive, but it is claimed that the shafts and the corresponding holes can be produced comparatively cheaply. The slots are cut to the necessary depth on a milling machine, with ordinary milling cutters, and the corresponding female part is cut with a series of broaches. The first cost of the broaches is, of course, rather high, but the amount of work they will perform before worn out is so considerable that the unit cost per each detail finished is very small. The actual fit of the parts takes place on the external diameter of the shaft. The grooves are so milled that they will provide for as close a fit as possible on their sides, but a small clearance is allowed in the bottom of the grooves.

TIGHTENING DEVICE FOR CONNECTING-ROD BRASSES.

An automatic device for connecting-rod brasses has recently been brought out by Messrs. Tangyes, Ltd., Smethwick, England. This device is shown in the accompanying cut, which is taken from the *Mechanical Engineer*, issue of February 28. The bearing brasses, instead of being fixed in the usual manner, are given freedom to rotate, when too loose, under the friction of the crank-shaft, and this rotation of the brasses is utilized to effect the tightening of the screws *A* in the con-



Rod Connection in which the Wear of the Brasses is Automatically taken up.

necting-rod end and its cap. On the outside circular surface of the bearing brasses a worm thread is cut as shown, and small worm-wheels are arranged in recesses in the cap and connecting-rod end. The holes through these worm-wheels are threaded right- and left-hand to engage with the tightening bolts *A* as shown. By this arrangement it is evident that if the brasses revolve slightly, they will cause a slight motion of the small worm-wheels, and this in turn will tighten up the cap of the connecting-rod against the end, by means of the right- and left-hand threads in the small worm-wheels. Should the bearing brasses be loose enough so that the friction between the crank-shaft and the brasses has a tendency to effect a rotation of the brasses, the pressure between the head and cap of the connecting-rod being insufficient to hold the brasses in place, a rotary motion of the brasses will take place and the worm-wheels will be rotated in the proper direction for drawing the screws inward, thereby tightening up the cap. When the pressure of the cap is sufficient to prevent the rotary motion of the brasses, these will remain stationary, and the crank-shaft will revolve as usual in its bearing. It will be seen that the bearing is thus automatically tightened whenever it becomes loose, and accident from the unfastening of the bearing is rendered impossible.

A SIMPLE CALCULATOR.

The accompanying cuts, reproduced from *Der praktische Maschinen-Konstrukteur* show a rather interesting and ingenious calculator of a simple and cheap design, intended for rapid multiplication. The construction is easily comprehended directly from the cuts. There are five stationary slides, provided with numbers from 1 to 99, and between each of these

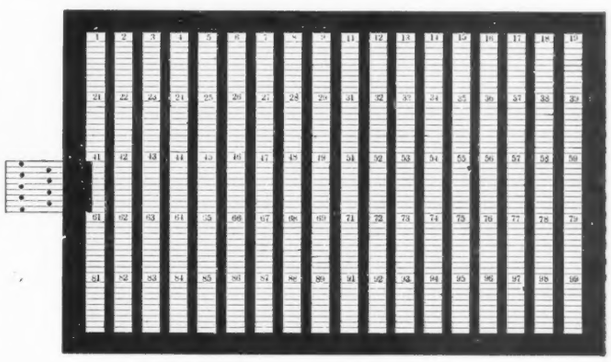


Fig. 1. Calculator for Rapid Multiplication.

rows of numbers there are nine movable slides which are numbered at the ends, 1, 2, 3, 4, etc. These movable slides are provided with figures, placed in a certain way, so that, by setting the slide, as indicated in Fig. 2, the product of the number on the stationary slide, and the number at the end of the movable slide can be read off at once; thus, for instance, 4×44 is 176. In the case in Fig. 2, the number 6,543 is to be multiplied with any of the numbers on the stationary slide. The product of each of the figures in 6, 5, 4 and 3 times 44 will be found directly under 44, as 132, 176, 220 and 264; the

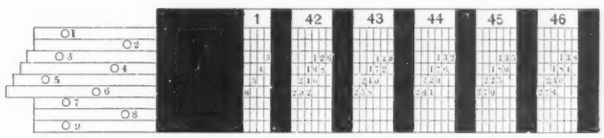


Fig. 2. Method of using the Calculator.

movable slides being set in proper order, all that is necessary to get the multiplication is to add, the same as in ordinary multiplication, getting the product 287,892. It is, however, not necessary that the one number with which another is multiplied should have only two figures. It is possible to figure with factors having four figures a great deal easier than by ordinary multiplication. Take a case, for instance, of $6{,}543 \times 4{,}546$. In this case, 4,546 is divided up in two parts, 45 and 46, and we have:

$$6543 \times ..46 = \quad 300978$$
$$6543 \times 45.. = 294435$$
$$29{,}744{,}478$$

The products of each part of the number 4,546 with 6,543 are found directly on the scale in Fig. 2, by simple addition, and the time required for multiplication is but a fraction of that ordinarily necessary, if we multiply in the usual way. The instrument is made by the Rechenapparate-Fabrik Fr. Schneider, München, Germany.

Copyright, 1908, by THE INDUSTRIAL PRESS.

Entered at the Post-Office in New York City as Second-Class Mail Matter.

MACHINERY

REGISTERED IN UNITED STATES PATENT OFFICE.

DESIGN—CONSTRUCTION—OPERATION.

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS,

49-55 LAFAYETTE STREET, CORNER OF LEONARD,

NEW YORK CITY.

Alexander Luchars, President and Treasurer.

Matthew J. O'Neill, Secretary.

Fred E. Rogers, Editor.

Ralph E. Flanders, Erik Oberg, Franklin D. Jones, Associate Editors.

The receipt of a subscription is acknowledged by sending the current issue. Checks and money orders should be made to THE INDUSTRIAL PRESS. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Single copies can be obtained through any newsdealer.

We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

MAY, 1908.

PAID CIRCULATION FOR APRIL, 1908, 23,179 COPIES.

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

A FAULT OF HANDLING FOREIGN TRADE.

It is a more or less common fault of machinery dealers to become indifferent to the fate of machines sold, after they are once accepted and paid for. This applies with special force to foreign trade, and one very serious mistake made by a few of our American machine tool builders is their selection of indifferent foreign representatives. The builder of a machine tool should not forget that the ability to handle it so as to secure its maximum efficiency is fully as important as the design itself. Very often the fate of a new design depends as much on the way the first operator handles it as on the general design. In a foreign field, where conditions are quite different from those under which the machine was designed, it is specially desirable that prejudice be not aroused because of misunderstanding the various functions of a new machine. We were deeply impressed with this view by a letter lately received from a foreign subscriber who is trying to do deep-hole drilling with certain American equipment. He wrote, in part, as follows:

"We depend greatly on American machine tools in this country [Belgium], but we never get, during the first months, the full value of the machine we buy. Everybody has to go through costly experiments before he learns to use the machine to its best advantage. The agent will sell you everything you order, but he does not take the least interest in whether you get the right tool for your use or not. He rarely knows the machine sufficiently well to point out what you want to know. He will give you a catalogue *printed in English*, and that is all. Lucky is the man who understands this language!"

This man wrote to us for specific instruction on deep-hole drilling that would enable him to use the equipment he had purchased. Is it not a serious condition of affairs when a foreign buyer and user of an American product finds it necessary to write to an American trade journal for help rather than to appeal to the manufacturer himself? This man probably felt that there was little opportunity of getting help from that direction, because he dimly realized that his equipment was not well-suited to his work. But why was not the proper equipment sold to him? Simply because the agent did not know his business, or, if he did know it, he apparently did not care enough about future sales to help this man out of his predicament.

OVERTIME, A CASE OF MISDIRECTED ENERGY.

A few weeks ago there was some discussion in Great Britain regarding the practice of certain firms working their men overtime, while most firms were laying off help, not having been able to run full time. The trade unions contended that because of the number of unemployed, firms having a greater amount of work to do than could be performed by their regular workmen in the stipulated number of working hours, should employ additional help rather than work overtime. In a case like this it may be difficult to say whether or not the contention of the labor unions was reasonable, for the rush in the shops which were working overtime may have been only temporary, and it might have been inadvisable to hire new help only to lay off such men within a few weeks.

However, it cannot be disputed that our industrial system under which men work in the shops one year, say, for ten, twelve, and even thirteen hours a day, only to find themselves the next year either thrown out of employment altogether, or only working five days a week, seven to eight hours per day, is very unsatisfactory. It is greatly to be doubted if this way of conducting a manufacturing business is more profitable than if the work were divided more evenly over the times of prosperity and depression. The majority of well-established firms could, without injury to their business and without fear of the future, prepare somewhat more than is common in this country for the day when the orders come in faster than the facilities of the shop enable them to be filled. If this were done, there would be less feverish overtime work in prosperous times, and during times of depression the results all around would be less disastrous. The great sums paid out for overtime work could be partly saved, and the saving invested to good advantage in keeping things going at a more even pace all the time. It may be said that this proposition is impracticable, but if it were, the general uniform balance of industrial conditions which is maintained on the European continent would not be possible. We can learn a profitable lesson from the way that such conditions are handled across the water—a lesson that would be greatly to our advantage. It may be added, however, that there are some indications that certain Continental firms are on the verge of adopting our methods, and running their works on the hand-to-mouth plan, but they will, without doubt, find this policy a decidedly inferior one.

* * *

INATTENTION.

The writer has just returned from an auction sale of tickets where large signs were displayed stating that, in every case, bids were a premium to be paid in addition to the basic price of tickets. To make assurance doubly sure, the fact was announced and explained from the platform. In the face of all this, no less than three persons bid in seats, and prepared to pay for them only the specified amount of the premium. Such experiences are repeated everywhere and every day, in the shop, the office, the school. They seem to be almost chronic. It is hard to define the cause. Is it due to mere inattention, or heedlessness, or to real lack of comprehension, or what? At all events, its results are disastrous to the prospects of many a young man whose mind is not upon his work.

Attention to business is the first sound law of success. The boy who does not have to be told twice, who carries "the message to Garcia," and brings back what he was sent to get, is the one who counts. It would be interesting, though saddening, to discover the aggregate annual loss in the average shop through inattention: The things done over because the first attempt was wrong; the things done wrong because the workman was not attentive enough to learn how to do them right; the piece spoiled because the feed was jammed in too deep; the drawings ruined because of miscalculation or error in layout. It would be a sorry exhibit. We are all looking for the boy who thinks; for him there is a prospect, but he is scarce in these days of the multitude who seem to think that the world owes them a living. If our education is to accomplish anything of which we can boast, it must create a feeling of personal responsibility and an attitude of careful attention.

ENGINEERING REVIEW.

CURRENT MECHANICAL EVENTS—LEADING ARTICLES OF THE TECHNICAL PRESS.

Official statistics place the number of automobiles in use in Germany at a figure of 36,022. Of these nearly 1,800 are trucks. Of the vehicles intended for carrying passengers more than half were used for business purposes.

The Cunard steamer, *Mauretania*, crossed the ocean last March during an eastward voyage, at an average speed of 24.42 knots, which is the highest speed ever attained by any steamer across the Atlantic.

The imports of Austrian petroleum into Germany are constantly increasing, while the imports of petroleum from Russia have decreased considerably. In the year 1902 Germany imported 16,800 tons of petroleum from Austria, and in 1906 the figure was 59,800 tons, while during the first half of 1907 the imports exceeded 45,000 tons.

A Dutch scientist, Kamerlingh-Onnes, has succeeded in producing helium in solid form; in other words, in freezing helium. There is now not a single element known which cannot be transformed into solid form. The temperature at which helium will freeze is claimed to be —272 degrees C, which is only one degree C. over absolute zero.

In the *Consular and Trade Reports* for February 20, it is stated that the tariff duties on catalogues, price lists, and advertising matter of similar character, which, as we mentioned in a previous issue, have hitherto been imposed by the commonwealth of Australia, have been removed, and that matter of this character will hereafter be admitted to the country free of duty.

The Italian ambassador at Washington has given out official information to the Department of State regarding an international exposition, to be held at Rome and Turin, Italy, in 1911, in commemoration of the 50th anniversary of the proclamation of the kingdom of Italy. The exposition in Rome will include art and history, and the Turin exposition will be devoted to the productive industries.

A new motor record, according to the *Practical Engineer*, was established on the Brooklands motor tracks in England by a 60 H. P., 6-cylinder Napier car, which covered 50 miles in 35 minutes and 15 seconds, and 150 miles in one hour and 46 minutes. In two hours the space covered was 169 miles, the average speed for this time having been 84½ miles an hour. The previcus best record was 151 miles in two hours.

The preliminary work for the electrification of portions of the main lines of the Swedish State railways, to which we have referred several times, has now progressed to the point where orders have been placed for some of the machinery for the power stations. To begin with, two water turbines, designed to deliver 12,500 H. P. each, have been ordered. These turbines will work with a head of 100 feet, and will deliver the required power at 187 revolutions per minute.

Flying machines built according to the same design as the Farman prize-winning aeroplane, fitted with 50-H.P. motors, can now be bought in England at a price of $6,000, or in America for $8,400, the latter figure including the import duty to this country of 40 per cent *ad valorem*. In this particular case the tariff seems to fill its place of protecting an infant industry, inasmuch as the manufacture of flying machines surely still is in its infancy in the United States.

We mentioned in our Engineering Review section last month that an international industrial exhibition is to be held this summer in Toulouse, France. According to *Industritidningen Norden*, the Permanent German Industrial Exposition Committee has pointed out that it does not seem advantageous for German manufacturers to take part in this exhibition. The reason is not given, although it may be assumed that the scope of the exhibition and its advertising value would not warrant the expense incurred by sending machinery for exhibition.

A radical departure along the line of making use of the surplus heat from electric generators will be made at the large electric power station at Trollhättan, Sweden. We have previously mentioned that the equipment will consist of generators which will carry a normal load of 10,000 H.P. The heat evolved from the generators, it is estimated, will be equivalent to 400 H.P. In order to prevent this heat from escaping into the engine room, a partition of iron has been placed within the machine, and each generator will be furnished with a fan so placed that it will draw cold air through a duct from the outside atmosphere. The air then passes through the generator, and will be driven in its heated state into various parts of the building where artificial heating is required. It is believed that sufficient heat can thus be supplied from the generators for heating all the adjoining rooms and buildings by hot air.

The growth of the ocean steamship continues. The *Lusitania* and *Mauretania* are not long to hold the palm for great size. The White Star Co. has made plans for two new ships 1,000 feet long and of 60,000 tons displacement. These new monsters, however, will not be ocean greyhounds. They will be comparatively slow boats, the promised speed rating being about 20 knots. The economy of the large vessel where plenty of business is assured is fully recognized, and the probabilities are that even larger boats than 1,000 feet length will be built within the next twenty years. Mr. Lewis Nixon, a naval expert of some reputation, prophesies ocean steamers a quarter of a mile long, driven by producer gas engines. The new White Star boats will be driven by reciprocating engines and turbines, the turbines being low pressure and driving screws in the center while the high pressure reciprocating engines are connected to side screws.

An interesting instance of the bending of a large steel pipe in a short time, by heating with an oil burner, is mentioned in the *Iron Trade Review*. The work was carried out in an eastern mining shop. A 10-inch steel pipe, 18 feet in length, was bent to right angles with a radius of 30 inches, without filling with sand or other material, in one hour and ten minutes. Three men were required for the work. One end of the pipe was fastened by wedges, and at the other end of the pipe a tackle was attached for pulling the pipe at the proper time. The burner was then applied to the pipe, at the point selected for the beginning of the bend, and a 20-inch section was heated, this operation requiring about six minutes. Then the pipe was pulled to the desired radius, the wedges were loosened, and the pipe was shifted for bending further down on the arc, until it was bent the required 90 degrees. With an air pressure of 60 pounds, the entire oil consumption was about 2½ gallons.

Fly-wheels with rims of reinforced concrete are a novelty which, according to *Industritidningen Norden*, has been introduced at a pumping station at Zwartkopjes in Transvaal, where ten pumps are installed, each having fly-wheels of a diameter of about 14 feet. These fly-wheels are provided with cast iron hubs, to which are screwed 16 spokes made of 4-inch pipe. The rim consists of a casing of sheet iron, in which is placed the actual rim of reinforced concrete, having a section 13 inches square. The concrete is reinforced with ¼-inch steel wire. The rim weighs about 6,000 pounds, and the whole fly-wheel weighs about 8,000 pounds. On the ten fly-wheels, this construction permitted a saving of nearly $10,000, most of which saving, however, is due to the enormously high transportation costs that would have been necessary to pay for the transport of fly-wheels of this size, if they had been made

entirely of cast iron, and shipped to the pumping works. Under the present conditions the rims, of course, were completed right at the pumping station.

A novel gas engine starter has been developed by the Oil City Gas Engine Co., consisting of a flash boiler furnishing superheated steam at high pressure which may be used in a gas engine in the same manner that compressed air is used for large engine units. According to a description in the *Engineering Record*, the boiler is of the coil type of small capacity, and is heated by a large gas burner. When in operation, the coil is heated to a red heat, and then a small quantity of water is injected by a hand pump. This water instantly flashes to steam of from 400 to 500 pounds pressure, and is then admitted to the engine cylinder. The first heating of the coil will furnish sufficient steam for turning the crank a number of revolutions, and if the engine then should fail to get in operation, a second heating of the coil will give another number of turns, and so on. A safety valve set at 500 pounds pressure protects the device from excessive pressure.

The extent of the automobile business in the United States can be comprehended from some figures which have been compiled by the Association of the Licensed Automobile Manufacturers for the year 1907. It is stated that the number of automobile factories amounts to more than 200, but it is extremely difficult to get any figures in this respect, as many so-called manufacturers of automobiles work on a very small scale, merely assembling a few machines from parts bought from part makers, and other factories, so far, only experiment. The number of employes in the factories is estimated at 58,000, the capital invested, $94,000,000, and the value of the product for the year mentioned, over $105,000,000. The increase in these last three years is remarkable. In 1904 the number of factories was given as 121, the number of employes as about 10,000, the capital invested as $20,500,000, and the value of the product as $26,650,000, approximately.

A writer in *Stahl und Eisen* states that China has enormous possibilities as an iron-producing country. Although as yet the country has not been thoroughly explored, enormous deposits of high grade ore are known to exist. It is estimated that the total ore resources are not much less than those of the United States. Coal is also available in fairly extensive quantities. The Chinese, however, have passed a law preventing foreign capital from being employed directly in mining operations in China. Foreign capital can be used only for the purchase of stock in Chinese companies. While this provision is by no means cheerfully accepted by foreign capitalists who see an opportunity for exploitation on a large scale in the newly-developed Chinese ore deposits, this provision may be a very wise one from the Chinese point of view. It is at least in harmony with the time-honored idea of protection, which the Chinese applied for many centuries before the western world conceived of this efficient means for the stifling of trade and the building up of monopolies.

On March 19, the two long cantilevers of the Blackwells Island Bridge across the East River, at New York City, were brought together above the middle of the stream. As regards capacity, this bridge will be the largest cantilever structure in the world, although there are some cantilever bridges that have a considerably longer span between the towers. The bridge will be double-decked and is 8,449 feet in length between terminals. The length of the main span is 1,182 feet (the span of the famous Forth Bridge in Scotland is 1,710 feet, and the span of the Quebec Bridge, one cantilever arm of which recently collapsed, is to be nearly 1,800 feet). On the Blackwells Island Bridge there will be a roadway wide enough for four three-horse teams to pass abreast. On each side of this roadway there will be two trolley tracks. The upper deck will carry two elevated railroad tracks, and two footbridges. The six tracks across the bridge are estimated to have a capacity of between 400,000 and 500,000 passengers a day. The total cost of the bridge, it is estimated, will be more than $20,000,000.

ELECTRIC TRANSMISSION OF PHOTOGRAPHS.

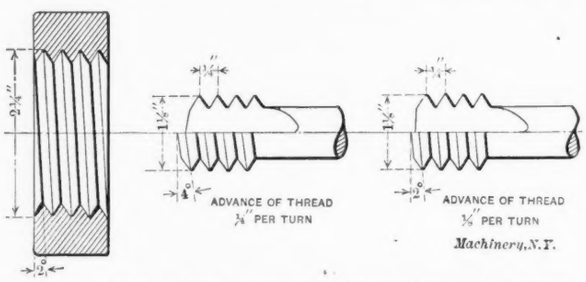
Electrical Engineering. January 2, 1908.

In the May, 1907, issue of MACHINERY, engineering edition, the principles of the Korn system of transmitting photographs by means of electricity, were explained. Another system for transmitting photographs electrically has been worked out by a Frenchman, Mr. Pascal Berjonneu. During experiments undertaken lately in Paris, wires were connected so that the photographs were transmitted through the line from Paris to Marseilles and back again to Paris, a distance of over one thousand miles. Pictures were successfully transmitted over this line. The apparatus was also connected to a wireless telegraph outfit, and the receiving apparatus placed in the same room as the transmitting apparatus, and the pictures were transmitted from the one to the other, wirelessly, this being the first time that this has been done. The new system differs from the Korn system in that use is not made of selenium. The principle of this system is that the picture to be sent is etched on a thin metal plate, which is rolled up to form a cylinder, and is mounted on a traveling drum, similar to that on a phonograph. An insulated platinum point is placed in front of the drum, so that it will come in contact with those portions of the cylinder only which stand in relief, that is, those portions which have not been influenced by the etching process. When the drum revolves, and contact is made between the metal plate and the platinum point, a current will pass through the transmitting wire for longer and shorter periods. The receiving apparatus consists of a film, sensitive to light, mounted on a cylinder, and a ray of light, controlled by a small shutter moved by a magnet through which the current passes, falls upon the film, thus reproducing the original picture. The reproduction, of course, consists of lines of dots and dashes corresponding to the etching.

CIRCULAR CHASERS FOR INTERNAL THREADING.

Mechanical Engineer. March 20, 1908.

Circular chasers for internal threading, such as shown in Fig. 2 of the accompanying cut, have been more or less used instead of ordinary inside thread tools, but when the difference in diameter between the hole to be threaded and the diameter of the chaser itself is considerable, there is a serious objection to the use of these internal chasers, particularly on coarse pitches. Referring to Figs. 1 and 2, it is evident that if the nut to be threaded is provided with four threads per inch, and the diameter of the thread equals 2¼ inches, then the actual angle of the thread with a line perpendicular to the axis of the nut is about 2 degrees. If now a circular



Figs. 1, 2 and 3. Section through Nut, Objectionable, and Improved Forms of Circular Chasers.

chaser is made, being 1⅛ inch in diameter, and having four threads per inch, it will be seen that the angle of this thread with a line at right angles to the axis of the chaser is 4 degrees. It is plain that when such a chaser is used for cutting the thread in the nut shown, there will be an interference between the part of the thread in the chaser which is below the cutting edge and the thread already cut in the nut, the side of the thread in the chaser rubbing up against one side of the thread in the nut. In order to overcome this defect, and at the same time offer the advantages inherent in the chaser form of thread-cutting tool, S. N. Brayshaw, Mulberry Street, Hulme, Manchester, England, has brought out an improved form of circular chaser. For cutting a nut of the kind shown in Fig. 1, a chaser such as shown in Fig. 3 would be used. In this, the flute or notch in the chaser which provides the cutting edges, is milled first, before any threads

are cut, and then the threads are cut by a milling cutter in a thread-milling machine with such a lead that the angle of the thread in the chaser will be the same as the angle of the thread in the nut to be cut, the shape of the thread, of course, still remaining the same as before. The thread is not a continuous thread, but each thread simply extends around the chaser from one edge of the flute or groove to the other. By this means a chaser is provided which will cut the thread required without interference. It is clear, of course, that different chasers will have to be made for various internal diameters, but on fine pitches, in particular, each chaser can take in a considerable range of different diameters without meeting with the objections that would prevail if the chaser simply had a thread of the regular pitch cut continuously around it.

THE QUEBEC BRIDGE DISASTER.

The chief conclusions of the royal commission, appointed by the Canadian government to investigate the cause of the failure of the Quebec Bridge, which collapsed on August 29, 1907, have been submitted to the Canadian Parliament. The summary of the findings of the commission are as follows:

A. The collapse of the Quebec bridge resulted from the failure of the lower chords in the anchor arm near the main pier. The failure of the chords was due to their defective design.

B. Stresses that caused the failure were not due to abnormal weather conditions or accident, but were such as might be expected in the regular course of erection.

C. The design of the chords that failed was made by P. I. Szlapka, the designing engineer of the Phœnix Bridge Co.

D. This design was examined and officially approved by Mr. Theodore Cooper, consulting engineeer of the Quebec Bridge & Railway Co.

E. The failure cannot be attributed directly to any cause other than errors in judgment on the part of these two engi neers.

F. These errors of judgment cannot be attributed either to lack of common professional knowledge, to neglect of duty or to a desire to economize. The ability of the two engineers was tried in one of the most difficult professional problems of the day and proved to be insufficient for the task.

G. We do not consider that the specifications for the work were satisfactory or sufficient, the unit stresses in particular being higher than any established by past practices. The specifications were accepted without protest by all interested.

H. A grave error was made in assuming the dead load in the calculations at too low a value and not afterwards revising this assumption. This error was of sufficient magnitude to have required the condemnation of the bridge even if the details of the lower chords had been of sufficient strength, because, if the bridge had been completed as designed, the actual stresses would have been considerably greater than those permitted by the specifications. This erroneous assumption was made by Mr. Szplaka and accepted by Mr. Cooper and tended to hasten the diaster.

I. We do not believe that the fall of the bridge could have been prevented by any action that might have been taken after August 27, 1907. Any effort to brace or take down the structure would have been impracticable, owing to the manifest risk of human life involved.

J. The loss of life in August, 1907, might have been prevented by the exercise of better judgment on the part of those in responsible charge of the work for the Quebec Bridge & Railway Company and for the Phœnix Bridge Company.

K. The failure on the part of the Quebec Bridge & Railway Company to appoint an experienced bridge engineer was a mistake. This resulted in a loose and inefficient supervision of all parts of the work on the part of the Quebec Bridge & Railway Company.

L. The work done by the Phœnix Bridge Company in making the detail drawings and in planning and carrying out the erection, and by the Phœnix Iron Company in fabricating the material was good, and the steel used was of good quality. The serious defects were fundamental errors in design.

M. No one connected with the general designing fully appreciated the magnitude of the work nor the insufficiency of the data upon which they were depending. The special experimental studies and investigations that were required to confirm the judgment of the designers were not made.

N. The professional knowledge of the present day concerning the action of steel columns under load is not sufficient to enable engineers to economically design such structures as the Quebec bridge. A bridge of the adopted span that will unquestionably be safe can be built, but in the present state of professional knowledge a considerably larger amount of metal would have to be used than might be required if our knowledge were more exact.

O. The professional record of Mr. Cooper was such that his selection for the authoritative position that he occupied was warranted, and the complete confidence that was placed in his judgment by the officials of the Dominion government and the Phœnix Bridge Company was deserved.

DIE SINKING AND ENGRAVING MACHINES.

The accompanying cuts, Figs. 1 and 2, show some interesting die-sinking and engraving machines, constructed by Messrs. Thomas Auty & Co., London, England. These machines are employed in a great variety of die-cutting work, and for engraving, and are used, to a great extent, in the British government shops for cutting the dies for various parts of rifles. The half-tone, Fig. 1, shows what is called the 42-inch Patent Die-sinking machine, which is the latest design brought out. The line cut, Fig. 2, shows exactly the same principle applied to a smaller machine, called the 27-inch die-sinking and engraving machine. The principle of these machines is that they copy from an enlarged former or model the form desired, reducing it by means of the pantograph arrangement shown.

The work to be operated upon is clamped to the table *A* under the head *C*. This head carries a milling cutter, constrained to follow the exact movement of the tracing-pin carried by head *D* along the form. The operating mechanism is carried on the table *A*, and consists of a pivoted arm *B*, the

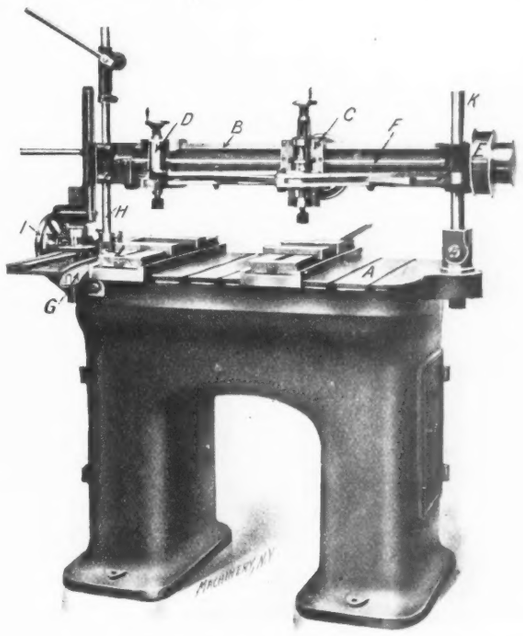


Fig. 1. Thomas Auty & Co.'s 42-inch Patent Die-sinking Machine.

end of which can be traversed in a horizontal plane around the axis of stud *K*. This arm is carried at its outer end by the roller *L* on the end of stud *H*, traveling along the circular path *G* of the machine table. The horizontal movement may be effected either directly by hand or mechanically through a pinion and rack, connecting with the hand-wheel *I*. As will be seen from the cut, at the right-hand end of the machine the arm *B* is carried by the stud *K*, which is, in turn, connected with the table by a universal joint, which permits the arm to rise and fall in a vertical plane, so as to accommodate itself to any irregular surfaces which there may be on the form, while, at the same time, the exact proportion between the cutter and the tracing-pin is maintained through the pantograph. By traversing the tracing head *D* longitudinally along the arm, a third movement is obtained, which imparts a relative, but reduced, motion to the cutting head *C*. The cutter spindle of head *C* is driven through a longitudinal shaft *F*, from the pulley *E* at the right-hand end of the machine. The drive in the head is through hardened steel helical gearing, carried in the slide itself. The arm *B* is secured to the stud *K* by means of a set-screw, the point of which

enters into a spline, as shown in the line cut, Fig. 2, so that the height of the arm may be varied according to the height of the work operated upon. The left-hand end of the arm is provided with a spring support on the end of rod *H* which takes the weight of the arm when vertical movements are required. This spring support is provided with the roller, as already mentioned. A thumb-screw is provided for preventing the spring from acting, thereby allowing the full weight of

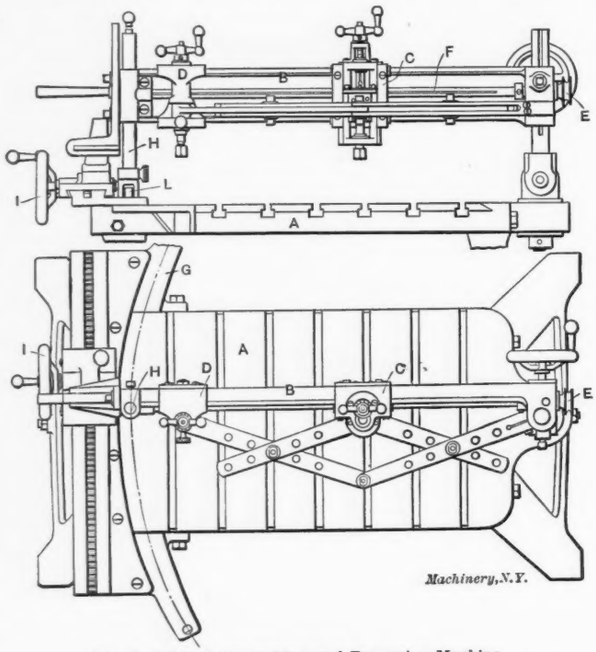


Fig. 2. 27-inch Die-sinking and Engraving Machine.

the arm to bear upon the work when necessary. In the machine in Fig. 1, reversible automatic feeds may be provided for both the longitudinal and transverse motion if required. The power is transmitted to the arm hand-wheel by a shaft in the back of the machine, driven through suitable gearing from the main shaft. The transverse movement is connected through a universal joint with the free end of the arm.

THE MANUFACTURE OF MACHINE TOOLS IN GERMANY.

Abstract of Report of Capt. Godfrey L. Carden, Special Agent of the Department of Commerce and Labor.

American manufacturers who have not heretofore attempted to analyze the European market, will find that German machine tool shops are turning out many machines that for practical shop work serve the purpose as well as the average American tool, and unless the German manufacturer can buy American machine tools cheaper than those made in his own country, he may be expected to patronize his own market. The majority of American manufacturers, however, can undersell the German tool manufacturers in German territory, despite the lower wages paid in Germany. This condition is due to the specializing and high standard of shop efficiency prevalent in America. Very few German establishments have attempted so far to confine themselves to a few lines of tools or to one type of machine, which specializing, of course, would greatly diminish the cost of production.

Many of the statements in the report are of a character that seems like the very rudiments of business requirements, but Capt. Carden says that he has been struck with the apparent ignorance on the part of many machine manufacturers in America, even men who are presidents of prominent concerns, of what constitutes the latest and most up-to-date practice in Europe. It is this very lack of knowledge which has probably had much to do with the failure of many American machine houses to accomplish more in the outside world. There is, however, some excuse for this, when we consider the great stress under which the home firms have been engaged during the last few years in the attempt to meet the enormous domestic demand. Under such conditions, there has been little incentive for many of our houses to study foreign markets.

The rate of wages has increased in German shops in recent years. The average wages paid at one large establishment is about 17 cents per man per hour. (In one large machine tool building firm in the United States the average wages paid per man per hour is 22 cents.—EDITOR.) The average working day is nine hours. The introduction of gages into Germany, as turned out by some of the best American firms, is serving as a potent factor in the development of the efficiency of the German workman. Measuring instruments are manufactured in Germany, but they are not recognized as equal to the best produced in America. There is very little competition in Germany on the part of English firms.

What concerns American manufacturers vitally is the fact that the Germans are putting more engineering thought into their designs than at any time in the history of tool construction. The mechanical skill still holds in favor of the Americans, and will probably remain to their credit in the case of those American firms which are paying close attention to the drafting-room. When tools from American firms are introduced into Germany, every feature of those tools will be the subject of close scrutiny, and if engineeering skill, backed up by careful mathematical deductions, make it possible to produce a better machine, the Germans will be among the first to discover the fact. The American firm need not, therefore, be surprised, if, in a very short time, there is found on the market a similar German tool, possibly American in its original idea, but essentially German in its improved form. It is therefore absolutely necessary for any American firm which proposes to hold its own in foreign competition, not to ignore technical education.

A visit to the A. Borsig plant, near Berlin, is referred to in the report. This plant employs about 5,000 men, and the managers have learned, to the highest degree, how to get the maximum work out of the machine tools. It would be surprising to many American manufacturers, says Capt. Carden, who believe that Americans alone understand shop efficiency, to take a walk through these shops, and he says that a glimpse of the workings of this particular plant would cause a realization of what there is ahead of America in foreign competition.

Practically one-half of the machinery production of Prussia is for export. The French have not been inclined for many years to patronize the German houses, but the merit of German production has forced itself even on the French buyer. On the whole, however, the Germans do not as yet understand in the great majority of cases how to operate the greatest number of machines with the least number of men, and the greatest improvement possible in German machine tool building is enhanced shop efficiency. The Germans, however, are learning fast in this respect, and if we propose to keep ahead in shop efficiency and in our ability to run a shop with the least possible number of men, there must be a thorough training of all those employed in the shop. In Germany, schools for apprentices are often established in the shops. These schools are presided over by men directly interested in the shop work. The apprentice works in the school-room either early in the morning, when he first comes to work, or at some other hour in the day, and the time devoted to the school-room is deducted from his wages. The education of the apprentice is carried along on carefully and well-thought-out lines, and always with the view of developing a highly skilled and technically trained man, developed, of course, particularly along the lines of work carried on by the firm employing him.

* * *

In a previous issue we referred, in a short note, to the tremendous volume of business done in the moving picture industry. The following additional information may be of interest, as indicating the proportions of the business. One of the largest French companies is employing about 1,000 people in its factories. For the production of moving pictures, two large theaters are in constant use, and a large park with artificial lakes, etc., is also included in the equipment. Outside of the employes in the factories, the company employs more than 300 actors for obtaining the scenes for the moving pictures.

MAXIMUM STRESSES—2.*

JOHN S. MYERS.†

Moments in Two Planes; Crane and Telpher Girders.

In the design of crane, telpher, and similar runways, not housed, suitable provision should be made for lateral strength to resist wind loads. This, in conjunction with considerations of the buckling tendency of the compression flange, makes a single I-beam or a built-up girder of symmetrical section undesirable. The three types of section most commonly used for these purposes consist of: 1st, an I-beam for vertical strength with a channel riveted to the compression flange for lateral stiffness; 2d, the same construction with the addition of a smaller channel to the tension flange to increase the vertical strength; and, 3d, two I-beams, side by side, with a cover plate on the top flanges only. Tables V and VI in the supplement of the present issue give properties of these three varieties of built-up sections. Most of the combinations are made up of the minimum weight sections rolled, which are the most economic to use and most readily obtained.

For the purpose of illustrating the use of these two tables in conjunction with Table II and Diagram III in the supplement of the March issue, the following notation is assigned to the various quantities entering into the calculation of a girder acted upon by a moving load, dead load, and wind loads, the moving load being carried on two wheels equally loaded:

W_l = live load, *i. e.*, the sum of the two wheel loads,
W_d = dead load, *i. e.*, the weight of the girder.
W_w = wind load, one-half of which is carried by each wheel.
W_n = normal wind load on girder,
L = length of span in inches,
B = wheel-base (center to center of wheel),
Z_c = section modulus of upper chord about axis $a\ a$,
Z_t = section modulus of lower chord about axis $a\ a$,
Z_w = section modulus of upper chord about axis $b\ b$.

Z_c, Z_t, and Z_w are to be taken from Tables V and VI in the the supplement.

V_m = variable for determining the moment due to wheel loads. Use the maximum value given by Table II or diagram III in the March issue supplement.

V_{mu} = variable for determining the moment due to uniformly distributed loads. Use the value given by the top curve of diagram III, where the same vertical ordinate as used for V_m intersects. If using Table II, take the value given opposite $R = 1$ or over, and in the same vertical column from which the maximum value of V_m was taken.

M_l = moment due to live load W_l.
M_v = moment due to all vertical loads, W_l and W_d.
M_w = moment due to wind loads W_w and W_n.
S_t = tensile stress due to M_v,
S_c = compressive stress due to M_v,
S_w = stress in top chord due to M_w,
S_{mc} = maximum combined compressive stress,
S = assumed stress used for determining the size of a trial section.

$$\text{Then } M_l = W_l\, L\, V_m \qquad (18)$$

$$M_v = L\,(W_l\, V_m + W_d\, V_{mu}) \qquad (19)$$

$$M_w = L\,(W_w\, V_m + W_n\, V_{mu}) \qquad (20)$$

$$Z_t = \frac{M_l}{S} \qquad (21) \qquad S_t = \frac{M_v}{Z_t} \qquad (22)$$

$$S_c = \frac{M_v}{Z_c} \qquad (23) \qquad S_w = \frac{M_w}{Z_w} \qquad (24)$$

If the structure is subjected to maximum wind while carrying full dead and live load, then

$$S_{mc} = S_c + S_w \qquad (25)$$

but since unhoused cranes, telphers, etc., are not reasonably supposed to be in operation during a wind storm little short of a hurricane, it is more logical to assume but half the wind loads, when combining with the maximum stresses due to live and dead load; then

$$S_{mc} = S_c + \frac{S_w}{2} \qquad (25a)$$

Example.—A girder, 30 feet span, supports 15 000 pounds on two wheels equally loaded. The wheel-base is 9 feet, the wind normal to the girder is taken at 30 pounds per square foot, and the area exposed to wind carried by the two wheels is 60 square feet. Find a suitable section, and state the maximum stress.

Solution.—$L = 30$ feet $= 360$ inches; $B = 9$ feet; $\frac{B}{L} = \frac{9}{30} = 0.3$; $W_l = 15{,}000$ pounds; $W_w = 60 \times 30 = 1800$ pounds.

From table II or diagram III (March issue supplement), the maximum value of $V_m = 0.1806$ for $\frac{B}{L} = 0\ 3$ or $B = 0.3\ L$, and for the uniformly distributed loads $V_{mu} = 0.1222$. For a trial section we have by formula (18) $M_l = W_l\, L\, V_m = 15{,}000 \times 360 \times 0.1806 = 975{,}240$ inch-pounds. Assuming the low fiber stress of 10,000 we have by formula (21)

$$Z_t = \frac{M_l}{S} = \frac{975{,}240}{10{,}000} = 97.5$$

From Table V, in the current supplement, the lightest weight girder having a section modulus Z_t in excess of this is seen to be composed of one 18 inch 55-pound I-beam with a 12-inch 20.5-pound channel on the top flange. For this section $Z_t = 99\ 11$, $Z_c = 161.57$, and $Z_w = 23.16$. The weight per foot is then $55 + 20.5 = 75.5$ and the total weight of girder is $W_d = 75.5 \times 30 = 2265$ pounds. By formula (19), $M_v = 360 \times (15{,}000 \times 0.1806 + 2265 \times 0.1222) = 1{,}074{,}882$ inch-pounds.

By formula (22)

$$S_t = \frac{M_v}{Z_t} = \frac{1{,}074{,}882}{99.11} = 10{,}820,$$

and by (23)

$$S_c = \frac{M_v}{Z_c} = \frac{1{,}074{,}882}{161.57} = 6660.$$

The depth of girder is 18 inches $= 1.5$ feet; the area exposed to wind is $1\ 5 \times 30 = 45$ square feet. Then

$$W_n = 45 \times 30 = 1350 \text{ pounds.}$$

By formula (20)

$$M_w = 360 \times (1800 \times 0.1806 + 1350 \times 0.1222) = 176{,}422.$$

Then by formula (24)

$$S_w = \frac{M_w}{Z_w} = \frac{176{,}422}{23\ 16} = 7610$$

The maximum stress is then, according to formula (25),

$$S_{mc} = 6660 + 7610 = 14{,}270 \text{ pounds per square inch,}$$

or, under the more logical assumptions of formula (25a),

$$S_{mc} = 6660 + \frac{7610}{2} = 10{,}465 \text{ pounds per square inch.}$$

Moments in Two Planes with Symmetrical Resisting Section.

The foregoing is an example of moments in planes at right angles to each other, but of such a special nature as to warrant classification under a specific heading. The most common case of moments in two places occurring in machine construction is that of shafting or pins supporting gears, drums, etc. In these cases the resisting section is round, and therefore symmetrical about any axis passing through the center of gravity. The stress in any particular plane is then proportional to the bending moment in that plane, and to find the maximum stress it is only necessary to find at what point the combined bending moment becomes a maximum, the moments in the various planes being susceptible of graphical combination in the same manner as forces. The point at which the combined moment is a maximum can generally be determined by an inspection of the problem, but when there is any doubt, the moments at the critical points should be calculated, and a scale diagram laid out for each plane in which moments occur. The ordinates of these diagrams can be combined for the various points where the maximum moment is liable to occur. To illustrate this method we will take an actual case.

Example.—The shaft shown in Fig. 4 is acted upon by the four forces P, P_1, P_2, and P_3, and by the two reactions. The forces P and P_1 are in the plane of line $E\,F$, and the moments they produce in this plane are represented by diagram A. The forces P_2 and P_3 are in the plane $G\,H$, their moments

* Continued from the March issue.
† Address: 2456 Almond St., Philadelphia, Pa.

being shown by diagram *B*. At *C* is shown the method of combining moments M_1 and M_5, producing the resultant moment M_{15}, which is the maximum moment occurring in the shaft at the point of application of the force P_1, the magnitude and direction of M_{15} being represented by the length and direction of the heavy line *c b*; *c a* is drawn parallel to *E F* and *a b* parallel to *G H*.

At *D* is shown the combination of M_2 and M_4 giving the resultant M_{24}, which is the maximum moment occurring at the point of application of force P_2. This resultant, M_{24}, exceeds in numerical value the moment at any other point of the shaft and is therefore the *maximum combined bending moment* for which it must be designed.

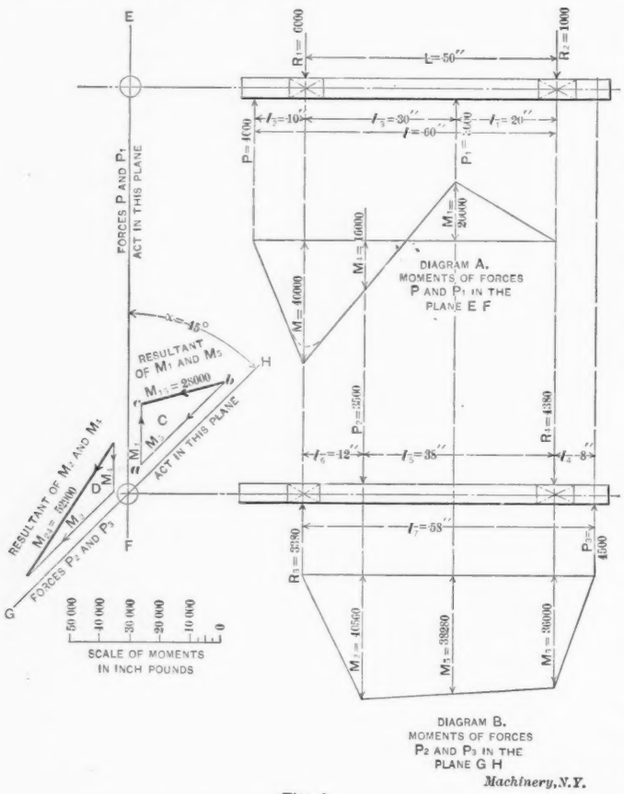


Fig. 4.

The method of calculating the reactions and moments at the various points used in making the diagrams of Fig. 4 is as follows:

$$R_1 = \frac{Pl + P_1 l_1}{L} = \frac{4000 \times 60 + 3000 \times 20}{50} = 6000 \text{ pounds.}$$

$$R_2 = \frac{P_1 l_3 - P l_2}{L} = \frac{3000 \times 30 - 4000 \times 10}{50} = 1000 \text{ pounds.}$$

$$M = Pl_2 = 4000 \times 10 = 40{,}000 \text{ inch-pounds.}$$

$$M_1 = R_2 l_1 = 1000 \times 20 = 20{,}000 \text{ inch-pounds.}$$

$$R_3 = \frac{P_3 l_4 + P_2 l_5}{L} = \frac{4500 \times 8 + 3500 \times 38}{50} = 3380 \text{ pounds.}$$

$$R_4 = \frac{P_3 l_7 - P_2 l_6}{L} = \frac{4500 \times 58 - 3500 \times 12}{50} = 4380 \text{ pounds.}$$

$$M_2 = R_3 l_6 = 3380 \times 12 = 40{,}560 \text{ inch-pounds.}$$

$$M_3 = P_3 l_4 = 4500 \times 8 = 36{,}000 \text{ inch-pounds.}$$

After laying out diagrams *A* and *B* from the above values, M_4 and M_5 may be scaled off, diagrams *C* and *D* constructed, and the final results M_{15} and M_{24} scaled off with sufficient accuracy for all practical purposes. If desired, they may be calculated. For this particular case

$$M_4 = M - \frac{M + M_1}{l_3} l_6 = 40{,}000 - \frac{40{,}000 + 20{,}000}{30} \times 12 = 16{,}000,$$

and

$$M_5 = \frac{M_2 + M_3}{2} = \frac{40{,}560 + 36{,}000}{2} = 38{,}280.$$

$$M_{24} = \sqrt{(M_4 \sin a)^2 + (M_2 + M_4 \cos a)^2} =$$

$$\sqrt{(16{,}000 \times 0.7)^2 + (40{,}560 + 16{,}000 \times 0.7)^2} = 52{,}900.$$

This latter is an unnecessary refinement which in practice would seldom, if ever, be resorted to, but is inserted here for purposes of illustration.

It will be noticed in the above solution that the forces were considered to be concentrated, no account being taken of the distributing action of the bearings. While this is quite customary, on account of simplifying the calculations, the error is sometimes considerable. In diagram *A* of Fig. 4, if the length of bearing *B* at the reaction R_1 is 7 inches, then the actual moment $M = P l_2 - \frac{R_1}{2} \times \frac{B}{4} = 34{,}750$. The diagram instead of coming to a sharp point should actually be rounded off as indicated by the dotted line.

Moments in Three Planes.

Fig. 5 is an illustration of moments in three planes, the proposition there presented being this: A shaft carries three drums, *A*, *A'* and *C*. *A* and *A'* are each acted upon by a rope whose load is represented by the force *F* at an angle of 30 degrees with the horizontal. An additional force F_1, due to the gears *B* and *B'*, acts at an angle of 90 degrees with the horizontal. Drum *C* carries a rope load F_2 on each side, and a gear load F_3 in the center, their direction being indicated by the dotted lines in the diagram.

The problem is to find the maximum combined bending moment.

Solution.—Force *F* is distributed over two bearings, their respective loads being *P* and P_1. $P = \frac{25{,}000 \times 7}{15} \cong 11{,}700$ and $P_1 = \frac{25{,}000 \times 8}{15} \cong 13{,}300$. The reaction due to *P* and P_1 is $R = 25{,}000$. The maximum moment in the plane of these forces is

$$M_0 = R(l + l_2) - P(l_1 + l_2) - P_1 l_2 = Rl - Pl_1 + l_2(R - P - P_1),$$

but since $R - P - P_1 = 0$, we have $M_0 = Rl - Pl_1$.

This shows that the moment for this case is the same in value as though the loads were concentrated at the center of the bearing, the only difference being that in the case of concentrated loads the moment would become maximum at point *H*, whereas with the load uniformly distributed over the bearing, the point of maximum moment shifts to *J* (see Fig. 5, diagram *D*). From the above may be stated the general principle that *for all cases of equal, symmetrically disposed loads acting in the same direction the maximum moment is the same in value whether the loads be concentrated at the center of bearings or distributed over their full length.* Then $M_0 = 25{,}000 \times 25 - 11{,}700 \times 15 \cong 449{,}500$ = maximum moment in the plane of *F*.

The force F_1, being central with a bearing, is all carried by that bearing. By the principle above stated its maximum moment is $M_1 = R_1 l = 18{,}100 \times 25 = 452{,}500$.

The forces F_2 and F_3 acting on drum *C* may be combined as in the diagram showing the direction of forces. This gives the resultant load $P_2 = 13{,}000$ pounds on each bearing of the drum. The maximum moment of P_2 in its plane is $M_2 = R_2 l_3 = 13{,}000 \times 35 = 455{,}000$.

Diagram *K* of Fig. 5 shows the combination of moments M_0, M_1 and M_2, giving the resultant *maximum combined bending moment* $M_{012} = 880{,}000$ inch-pounds, which is the moment for which the shaft must be designed.

Use of Table VII in the Supplement.

After the maximum moment to which a shaft is subjected has been found, the next step is to find what size must be used to withstand this and not exceed a safe fiber stress. By formula (8) in the March issue $Z = \frac{M}{S_b}$, where Z = section modulus, M = moment, and S_b = stress. Table VII in the supplement gives the value of Z for diameters ranging from 1/16 inch to 10 inches. It also gives the moment of inertia I for use when investigating for deflection. Formulas for

deflection covering various cases are given on data sheet No. 48 of the September, 1905 issue.

The values given in the supplement, Table VII, should be used for bending moments only. For torsional moments, the polar moment of inertia and section modulus should be used; but since these quantities are just double those for a rectangular axis, multiply the values in the table by 2.

The use of this table can best be illustrated by actual problems.

Example.—In the case shown by Fig. 4 the maximum combined bending moment was 52,900 inch-pounds. Using a fiber stress not exceeding 10,000 pounds per square inch, what size should the shaft be?

Solution.—By formula (8) the required section modulus is $Z = \frac{52{,}900}{10{,}000} = 5.29$. Referring to Table VII in the supplement, it is seen that for a 3 13/16-inch shaft $Z = 5.44$, which satisfies the conditions of the problem.

Example.—In the case illustrated by Fig. 5, the maximum moment was 880,000 inch-pounds. Allowing 25 per cent for

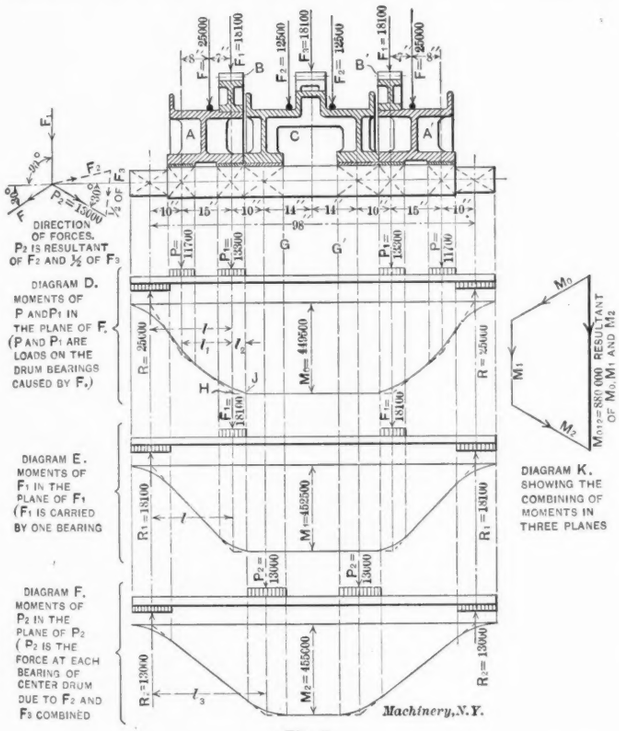

DIRECTION OF FORCES. P2 IS RESULTANT OF F2 AND ½ OF F3
DIAGRAM D. MOMENTS OF P AND P1 IN THE PLANE OF F. (P AND P1 ARE LOADS ON THE DRUM BEARINGS CAUSED BY F.)
DIAGRAM E. MOMENTS OF F1 IN THE PLANE OF F1 (F1 IS CARRIED BY ONE BEARING
DIAGRAM F. MOMENTS OF P2 IN THE PLANE OF P2 (P2 IS THE FORCE AT EACH BEARING OF CENTER DRUM DUE TO F2 AND F3 COMBINED
DIAGRAM K. SHOWING THE COMBINING OF MOMENTS IN THREE PLANES
Machinery,N.Y.

Fig. 5.

impact, what diameter of shaft may be used without exceeding a maximum stress of 15,000 pounds per square inch?

Solution.—25 per cent of 880,000 = 220,000.

$M = 880{,}000 + 220{,}000 = 1{,}100{,}000$.

$Z = \frac{1{,}100{,}000}{15{,}000} = 73.33$. Referring to the supplement for 9-inch diameter. $Z = 71.57$ and for 9¼ inch diameter $Z = 77.7$; a 9⅛-inch shaft would then answer the purpose.

Example.—A shaft resists 50,000 inch-pounds torsional moment, what should be its diameter for a fiber stress of 8,000 pounds per square inch?

Solution.—Polar section modulus $= \frac{50{,}000}{8{,}000} = 6.25$. Value in table $= \frac{1}{2} \times 6.25 = 3.125$. For a 3⅛-inch shaft, the table gives $Z = 2.996$, and for 3 3/16-inch shaft $Z = 3.179$. Either of these sizes would be sufficiently near to satisfy the conditions.

Example.—What is the deflection of an 8¾-inch shaft loaded as shown in Fig. 6, taking the coefficient of elasticity at $E = 30{,}000{,}000$?

Solution.—Referring to data sheet No. 48, September, 1905, deflection $f = \frac{W a}{24 E I}(3l^2 - 4a^2)$. For this problem $W = 26{,}000$, $l = 96$, $a = 34$.

From Table VII in the supplement of this issue $I = 287.7$ for an 8¾-inch shaft. Then the deflection $f =$

$$\frac{26{,}000 \times 34}{24 \times 30{,}000{,}000 \times 287.7} \times (3 \times 96^2 - 4 \times 34^2) = 0.098 \text{ inch.}$$

Example.—If in the last problem it is required to reduce the deflection to 1/16 = 0.0625 inch and use a coefficient of elasticity $E = 28{,}000{,}000$, what should be the shaft diameter?

Solution.—Let I, E and f be the values under the first condition, and I', E' and f' the corresponding values under the second condition. The deflection is inversely proportional to the moment of inertia and the coefficient of elasticity, then the required moment of inertia

$$I' = \frac{I f E}{f' E'} = \frac{287.7 \times 0.098 \times 30{,}000{,}000}{0.0625 \times 28{,}000{,}000} \cong 483.$$

Referring to the supplement, it is seen that for a 10-inch shaft $I = 490$. Ten inches is then the required size under these conditions.

Combining Shear with Tension or Compression.—Table VIII.

The usual formulas given for the combination of shear with tension or compression are:

$$S_m = \sqrt{S^2 + \left(\frac{t}{2}\right)^2} \qquad (26)$$

and

$$t_m = \frac{t}{2} + \sqrt{S^2 + \left(\frac{t}{2}\right)^2} \qquad (27)$$

in which the letters have the following values:

S = unit shearing stress if acting alone.

t = unit tensile or compressive stress if acting alone.

S_m = maximum combined shear.

t_m = maximum combined tension or compression.

Both the above formulas, involving as they do the square and square root, are rather awkward to apply. Equation (26) may be expressed

$$S_m = S\sqrt{1 + \left(\frac{1}{2}\frac{t}{S}\right)^2} = S\,y \qquad (26a)$$

in which

$$y = \sqrt{1 + \left(\frac{1}{2}\frac{t}{S}\right)^2}$$

and formula (27) may be written

$$t_m = t\left[\frac{1}{2} + \frac{1}{2}\sqrt{\left(2\frac{S}{t}\right)^2 + 1}\right] = t\,x \qquad (27a)$$

in which

$$x = \frac{1}{2} + \frac{1}{2}\sqrt{\left(2\frac{S}{t}\right)^2 + 1}.$$

The value x then represents a factor by which to multiply the tension and arrive at the maximum combined tension, while y represents a similar factor by which to multiply the shear when the maximum combined shearing stress is desired. Table VIII in the supplement gives values of x and y for values of $\frac{S}{t}$ and $\frac{t}{S}$ ranging from 0.05 to 1.5.

To make the significance of these values clear, refer to the table, and note that for $\frac{S}{t} = 0.75$, $x = 1.40$, which means that if the shear is 75 per cent of the tension, the maximum combined tension is 1.40 times what it would be if there were no shear or an increase of 40 per cent. For the same value of $\frac{S}{t} = 0.75$, $y = 1.20$, which indicates that the maximum combined shear is 1.20 times what it would be if there were no tension or an increase of 20 per cent. Again, referring to the table for $\frac{t}{S} = 0.75$, $y = 1.07$ and $x = 1.92$ approximately, which shows that when the tension is 75 per cent of the shear the maximum combined shear is only 7 per cent greater than if there were no tension, but the maximum combined tension is 92 per cent in excess of what it would be if acting alone.

The combination of shearing stresses, produced by torsion, with tension or compression stresses due to bending, will be taken up in a later issue.

Stresses Due to Torsional Deformation.

When a machine element or member is subjected to a known torsional moment, an angular deformation occurs, or, if deformed torsionally a known amount a resultant shearing stress is produced. The following notation and formulas express the relations of the various quantities involved:

L = length of member in inches.

C_p = distance from polar axis of the section to the extreme fiber in inches.

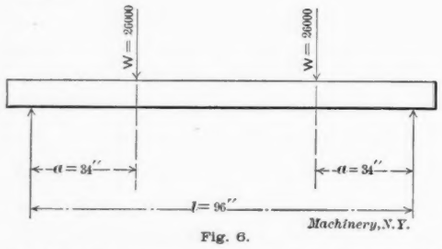


Fig. 6.

S = the shearing stress in pounds per square inch.

M_t = the torsional moment in inch pounds.

I_p = the polar moment of inertia.

E_s = the modulus of elasticity for shear (given by Reuleaux as 0.4 of that for tension).

ϕ = torsional angle in radians.

a = torsional angle in degrees.

$$\text{Then } \phi = \frac{M_t L}{I_p E_s} = \frac{S L}{E_s C_p} \qquad (28)$$

$$a = 57.296 \frac{M_t L}{I_p E_s} = 57.296 \frac{S L}{E_s C_p} \qquad (29)$$

$$S = \frac{\phi E_s C_p}{L} = 0.01745 \frac{a E_s C_p}{L} \qquad (30)$$

Eye bars are sometimes used for supporting a load, while at the same time subjected to a torsional deformation. An example of this is seen in some bridge tramways where one end of the bridge is supported by a number of bars, permitting the bridge to slew through an angle of several degrees by twisting the bars.

Example.—A 4 × ¾-inch bar 24 feet long, sustaining a load of 21,000 pounds, is twisted through an angle of 5 degrees. What are the maximum stresses?

Solution.—$L = 24 \times 12 = 288$ inches.

$C_p = \sqrt{2^2 + 0.375^2} = 2.03$ inches. $a = 5$ degrees.

E_s 0.4 × 27,000,000 = 10,800,000. By formula (30)

$$S = \frac{0.01745 \times 5 \times 10{,}800{,}000 \times 2.03}{288} \cong 6650.$$

The direct tension is

$$\frac{\text{load}}{\text{area}} = \frac{21{,}000}{4 \times 0.75} = 7000. \qquad \frac{S}{t} = \frac{6650}{7000} = 0.95.$$

Referring to Table VIII in supplement, it is seen that the tension factor $x = 1.573$, and shear factor $y = 1.130$. Then by formula (27a) maximum tension $t_m = tx = 7{,}000 \times 1.573 \cong 11{,}010$. By formula (26a) the maximum shear $S_m = Sy = 6650 \times 1.130 \cong 7{,}510$.

As an example of bending, direct tension, and shear, also illustrating the method of determining moment of inertia of unsymmetrical sections, take the corner section on a C-frame, as illustrated in Fig. 7. This section is subjected to a bending moment equal to WL, where W equals 360,000 pounds, and L is the perpendicular distance from the line of action of the force to the center of gravity of the section. In addition to the bending moment, there is acting upon this section a force P, which is equal to W cos a and is uniformly distributed over the section as tension; the other component P_1, which is equal to W sin a, is uniformly distributed over the section as shear.

In order to find the magnitude of the various stresses it is first necessary to find the area, center of gravity and moment of inertia of the section. Proceeding to find the center of gravity, take moments of the elementary areas of which the section is composed about some assumed line of reference, as x x, and divide the algebraic sum of the moments by the total area; the quotient is the distance from this line to the center of gravity. The operations are as follows:

Areas.	Moments.
$10 \times 4 = 40.000$	$\times 2.00 = 80.00$
$1.25 \times 13.5 = 16.875$	$\times 10.75 = 181.41$
$6 \times 2.5 = 15.000$	$\times 18.75 = 281.25$

A = total area = 71.875 Sum of moments = 542.66

$\frac{542.66}{71.875} \cong 7.55$ inches to center of gravity of section = C_t for tension flange; $20 - 7.55 = 12.45$ inches = C_c for compression flange.

To get the moment of inertia, multiply each area by the square of its distance from the center of gravity of the entire section and add to each its moment of inertia about its own center of gravity. The moment of inertia of a rectangle being $\frac{b h^3}{12}$, the problem becomes:

$$40 \times 5.55^2 + \frac{10 \times 4^3}{12} = \begin{cases} 1232.10 \\ 53.33 \end{cases}$$

$$16.875 \times 3.2^2 + \frac{1.25 \times 13.5^3}{12} = \begin{cases} 172.80 \\ 256.29 \end{cases}$$

$$15 \times 11.2^2 + \frac{6 \times 2.5^3}{12} = \begin{cases} 1881.60 \\ 7.81 \end{cases}$$

$$I_r = 3603.93$$

The moment $M = WL = 360{,}000 \times 14.25 = 5{,}130{,}000$ inch-pounds. The tension is, $S_t = \frac{M C_t}{I}$ and the compression is

$$S_c = \frac{M C_c}{I}.$$

$$\text{Then } S_t = \frac{5{,}130{,}000 \times 7.55}{3603.93} = 10{,}747, \text{ and}$$

$$S_c = \frac{5{,}130{,}000 \times 12.45}{3603.93} = 17{,}722.$$

In this case the tension due to P and the shear due to P_1 are equal since sin 45 deg. = cos 45 deg. The value of these stresses is then

$$\frac{W \sin a}{A} = \frac{360{,}000 \times 0.707}{71.875} = 3542.$$

Adding this to the stress in the tension flange, since this is also tension, and subtracting it from the stress in the compression flange we have: $10{,}747 + 3{,}542 = 14{,}289$ pounds per square inch tension, and $17{,}722 - 3{,}542 = 14{,}180$ pounds per square inch compression. Combining with the shear by formula (27) we have for the maximum combined tension

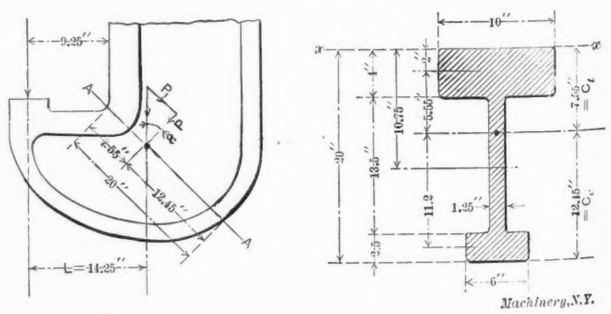


Fig. 7.

$$t_m = \frac{14{,}289}{2} + \sqrt{3542^2 + \left(\frac{14{,}289}{2}\right)^2} = 15{,}122 \text{ pounds per sq. in.}$$

The compression is so nearly the same value as the tension that it will be unnecessary to combine the shearing stresses in this case by separate calculation.

JIGS AND FIXTURES—2.

EINAR MORIN.*

GUIDING THE DRILL.

The guides for the cutting tools in a drill jig take the form of concentric steel bushings, which are hardened and ground and placed in the jig body in proper positions. The bushings may be either stationary or removable, which latter, in the shop, are usually termed loose bushings. The most common, and the preferable form for the stationary bushing is shown in Fig. 5. This bushing is straight both on the inside and on the outside, excepting that the upper corners *A* on the inside are given a liberal radius, so as to allow the drill to enter the hole easily, while the corners *B* at the lower end of the outside are slightly rounded for the purpose of making it easier to drive the bushing into the hole, when making the jig, and also to prevent the sharp corner on the bushing from cutting the metal in the hole into which the bushing is driven.

When removable bushings are used, they should never be placed directly in the jig body except if the jig be used only a few times, but this should always be provided with a lining bushing. This lining bushing is always made of the form shown in Fig. 5. If the hole bored in the jig body receives the loose or removable bushing directly, the inserting and removing the bushing, if the jig is frequently used, would soon wear the walls of the hole in the jig body, and after a while the jig would have to be replaced, or at least the hole would have to be bored out, and a new removable bushing made to fit the larger-sized hole resulting. In order to overcome this, the hole in the jig body is bored out large enough to receive the lining bushing referred to, which is driven in place. This

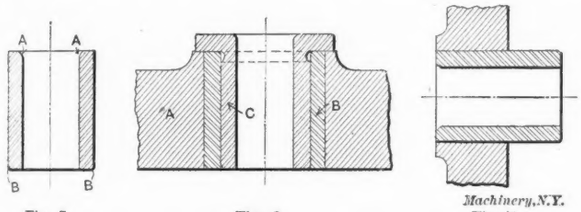


Fig. 5. Fig. 6. Fig. 7.

Guide and Lining Bushings for Drill Jigs.

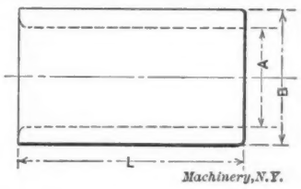
lining bushing then, in turn, receives the loose bushings, the outside diameter of which closely fits the inside diameter of the lining bushing, as shown in Fig. 6, in which *A* is the jig body, *B* the lining bushing, and *C* the loose bushing. Both of these bushings are hardened and ground so that they will stand constant use and wear for some length of time. When no removable bushings are required, the lining bushing itself becomes the drill bushing or reamer bushing, and the inside diameter of the lining bushing will then fit the cutting tool used. The bushing shown in Fig. 5 is cheaper to make, and will work fully as well when driven in place in the hole receiving it, as do bushings having a shoulder at the upper end, as has the loose bushing shown in Fig. 6. It was the practice some years ago to make all bushings with a shoulder, but this is entirely unnecessary, and simply increases the cost of making the bushing.

Dimensions of Jig Bushings.

It is rather difficult to give any standard dimensions for jig bushings as these depend, in most cases, on the different conditions of the various classes of jigs in which the bushings are inserted. As a rule the common practice is to make the length of the bushing twice the inside diameter of the hole in the bushing for stationary drill bushings. On very small bushings, however, say ¼ inch diameter hole and less, the length of the bushing will have to be made longer than twice the diameter, while on very large bushings the length may be made somewhat less than twice the diameter. The accompanying Table I gives proportions of stationary drill bushings. The dimensions, as here given, will be found suitable in all cases where no special conditions demand deviation from ordinary practice. If the jig wall is thin, the bushing may project out as shown in Fig. 7, so as to give the cutting tool the proper guiding and support as close to the work as possible. In Table II are given dimensions for lining bushings, not intended to directly guide the drill, but to hold removable bushings, which in turn, guide the cutting tools. The dimensions given in Tables I and II are for bushings made from tool steel or machine steel.

While it may be, in some cases, difficult to draw a distinct line between stationary drill bushings and lining bushings, it may be said in general, that the bushings in Table I are

TABLE I. DIMENSIONS OF STATIONARY DRILL BUSHINGS.



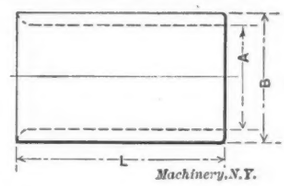
A	B	L	A	B	L	A	B	L	A	B	L
1/16	3/16	3/8	9/16	13/16	1 1/8	1 1/16	1 7/16	2	1 9/16	1 15/16	2 3/4
1/8	1/4	1/2	5/8	7/8	1 1/4	1 1/8	1 1/2	2 1/8	1 5/8	2	2 7/8
3/16	5/16	1/2	11/16	15/16	1 3/8	1 3/16	1 9/16	2 1/4	1 11/16	2 1/8	2 7/8
1/4	3/8	5/8	3/4	1	1 1/2	1 1/4	1 5/8	2 1/4	1 3/4	2 1/4	3
5/16	1/2	5/8	13/16	1 1/8	1 1/2	1 5/16	1 11/16	2 1/4	1 13/16	2 5/16	3 1/8
3/8	9/16	3/4	7/8	1 3/16	1 5/8	1 3/8	1 3/4	2 3/8	1 7/8	2 3/8	3 1/4
7/16	5/8	3/4	15/16	1 1/4	1 3/4	1 7/16	1 13/16	2 3/8	1 15/16	2 7/16	3 3/8
1/2	11/16	1	1	1 3/8	1 7/8	1 1/2	1 7/8	2 1/2	2	2 1/2	3 1/2

used for guiding the drills when drilling holes directly, either with a full-sized drill, when the hole is not required to be very smooth or accurate, or, if greater accuracy is required, for guiding a spotting drill which fits the bushing exactly, after which the hole is drilled out with a so-called reamer drill which is 0.010 inch or less under the size of the finished hole, and finally reamed out with a reamer fitting exactly the hole in the bushing. These bushings are thus, in general, used when no tapping or counterboring would be required. The lining bushing in Table II again may guide one of the tools for the holes to be finished directly, and then removable bushings are inserted to guide the other tools used.

Miscellaneous Types of Drill Bushings.

As already mentioned, it was, some years ago, always the practice to provide even stationary bushings with a shoulder or head, as shown in bushing *C*, Fig. 6. This will prevent

TABLE II. DIMENSIONS OF LINING BUSHINGS.

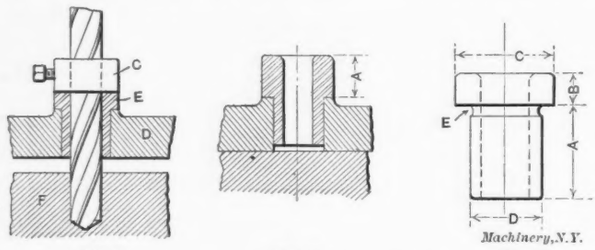


A	B	L	A	B	L	A	B	L
5/16	1/2	1/2	1 1/8	1 1/2	1 1/2	2 1/8	2 5/8	2 5/8
3/8	9/16	1/2	1 1/4	1 5/8	1 5/8	2 3/16	2 11/16	2 3/4
7/16	5/8	5/8	1 5/16	1 11/16	1 3/4	2 1/4	2 3/4	2 7/8
9/16	13/16	5/8	1 3/8	1 3/4	1 7/8	2 5/16	2 7/8	2 7/8
5/8	7/8	3/4	1 7/16	1 13/16	2	2 3/8	3	3
11/16	15/16	3/4	1 9/16	1 15/16	2 1/8	2 9/16	3 3/16	3 1/8
3/4	1	1	1 5/8	2	2 1/4	2 5/8	3 1/4	3 1/2
13/16	1 1/8	1 1/8	1 3/4	2 1/4	2 1/4	2 11/16	3 5/16	3 3/8
15/16	1 1/4	1 1/4	1 13/16	2 5/16	2 1/4	2 3/4	3 3/8	3 1/8
1	1 3/8	1 3/8	1 7/8	2 3/8	2 3/8	...	...	..
1 1/16	1 7/16	1 1/2	1 15/16	2 7/16	2 1/8	...	...	..

the bushing from being pushed through the jig by the cutting tool, but this seldom occurs if the bushings are made to fit the tool correctly. Sometimes the shoulder is used to take the thrust of a stop collar, which is clamped on the drill, to allow it to go down to a certain depth, as shown in Fig. 8, in which *C* is the stop collar, *D* the wall of the jig, and *E* the stationary bushing, *F* being the piece worked upon. In such a case, a shoulder on the bushing may be in place.

* Address: 833 W. Sixth St., Plainfield, N. J.

If the work to be drilled is located against a finished seat or boss on the wall of the jig, and the wall is not thick enough to take a bushing of standard length, then it is common practice to make a bushing having a long head, as shown in Fig. 9. The length *A* of the head can be extended as far as necessary to get the proper bearing. As the bushing is driven in place, and the shoulder of the head bears



Machinery, N.Y.

Fig. 8. Fig. 9. Fig. 10.

Types of Drill Jig Bushings for Different Purposes.

against the finished surface of a boss on the jig, it will give the cutting tool almost as rigid a bearing as if the jig metal surrounded the bushing all the way up.

Stationary or fixed drill bushings are almost invariably made from tool steel, but machine steel bushings, case-hardened and ground, give good service and wherever it seems necessary to save in the expense of the jig, machine steel will serve the purpose well enough for any jig that is not in constant use. For large bushings in particular, the difference becomes quite considerable, and, therefore, a great many prominent firms have made it a rule to make all larger bushings and, in particular, all lining bushings of machine steel.

Removable bushings are frequently used for work which must be drilled, reamed, and tapped, there then being one bushing for each of the cuttting tools. They are also used when different parts of the same hole are to be drilled out to different diameters, or when the upper portion of the hole is counterbored, or when a lug has to be faced off. In this case, each tool, of course, has its own guiding bushing. The common design of removable bushing is as shown in Fig. 10. The outside is made to fit the inside of the lining bushing with a nice, sliding fit, so that it can be gently pressed into the lining bushing by the hand. The distance *A* under the head of the bushing should be the same length or longer than the guiding bushing; in the latter case for the purpose of getting close to the work. The thickness *B* of the head varies, of course, according to the size of the bushing. The diameter *C* of the head should be from ¼ to ½ inch larger than the diameter *D* of the bushing. A groove *E*, ⅛ to ¼ inch wide, is cut immediately under the head, so that the emery wheel can pass clear over the part being ground.

Means for Preventing Loose Bushings from Turning.

In order to prevent the bushings from turning, in some shops a collar, with a projecting tail, as shown in Fig. 11, is forced over the head of the bushing. This arrangement also

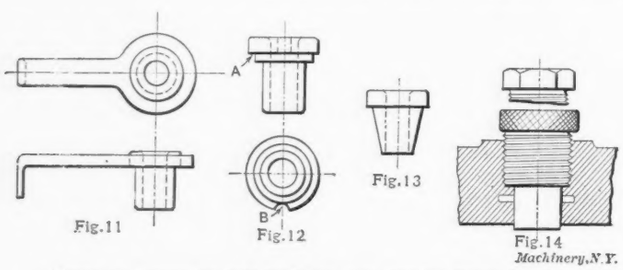


Fig. 11 Fig. 12 Fig. 13 Fig. 14

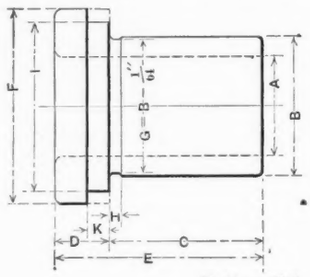
Machinery, N.Y.

Means for Preventing Drill Bushings from Turning, Taper Bushing, and Screw Bushing.

makes it easy to remove the bushing. The dog, as it is commonly called, is usually bent at the end of the tail, as shown in the cut, one end resting against some part of the jig, the proportions of which the dog must suit. Sometimes the bent end is left straight, if there is a possibility for the tail to strike against some lug in the same plane. The making of such dogs involves some extra expense, but it is very effective in avoiding troubles with bushings turning and working their way out of the holes. In some cases simply a hole is drilled in the shoulder of the bushing at the edge, and a corresponding pin is driven into the jig body. This serves the same purpose as the dog. It is probably cheaper, but it does not add the convenient means for removing the bushing as does the dog. To make such a bushing more easily removable, the arrangement shown in Fig. 12 is probably the most common. A step *A* is turned down on the head, which, in this case, will have to be a trifle larger in diameter. This step permits some kind of a tool—a screw driver, for instance—to be put underneath, and with a jerk the bushing may be lifted enough to get a good hold on it. The half-round slot at *B* is milled or filed in the periphery of the head, and fits over a pin or screw which is fastened in the jig body, as mentioned before. There are, of course, a number of other devices for preventing drill bushings from turning, but the ones shown will serve the purpose of plainly exhibiting the principles.

In Table III are given dimensions for removable bushings of the type shown in Fig. 12. As will be seen in the engraving above the table, dotted lines have been shown, indicating a

TABLE III. DIMENSIONS OF REMOVABLE DRILL BUSHINGS.



Machinery, N.Y.

A	B	C	D	E	F	H	I*	K*
1/8	5/16	1/2	1/8	5/8	5/8	1/8	1/2	1/32
3/16	11/32	17/32	1/8	5/8	5/8	1/8	17/32	1/32
1/4	7/16	9/16	1/8	5/8	5/8	1/8	9/16	1/32
5/16	9/16	5/8	1/8	5/8	5/8	1/8	5/8	1/32
3/8	5/8	11/16	1/8	5/8	5/8	1/8	11/16	1/32
7/16	11/16	3/4	1/8	1	1	1/8	3/4	1/32
1/2	3/4	1	1/8	1 1/8	1	1/8	1	1/32
9/16	13/16	1 1/8	1/8	1 1/4	1 1/8	1/8	1 1/8	1/32
5/8	15/16	1 1/4	1/8	1 3/8	1 1/4	1/8	1 1/4	1/32
11/16	1	1 3/8	3/16	1 1/2	1 3/8	1/8	1 3/8	1/16
3/4	1 1/16	1 1/2	3/16	1 5/8	1 1/2	1/8	1 1/2	1/16
13/16	1 1/8	1 5/8	3/16	1 3/4	1 5/8	1/8	1 5/8	1/16
7/8	1 1/4	1 3/4	3/16	1 7/8	1 3/4	1/8	1 3/4	1/16
15/16	1 5/16	1 7/8	3/16	2	1 7/8	1/8	1 7/8	1/16
1	1 3/8	1 7/8	1/4	2 1/8	1 7/8	3/16	1 7/8	3/32
1 1/16	1 7/16	2	1/4	2 1/4	2	3/16	2	3/32
1 1/8	1 9/16	2 1/8	1/4	2 3/8	2	3/16	2 1/16	3/32
1 3/16	1 5/8	2 1/4	1/4	2 3/8	2	3/16	2 1/16	3/32
1 1/4	1 3/4	2 1/4	1/4	2 3/8	2 1/8	3/16	2 1/16	1/8
1 5/16	1 13/16	2 1/4	5/16	2 3/8	2 1/8	3/16	2 1/16	1/8
1 3/8	1 7/8	2 3/8	5/16	2 3/8	2 1/4	3/16	2 1/16	1/8
1 7/16	1 15/16	2 3/8	5/16	2 3/8	2 1/4	3/16	2 3/16	1/8
1 1/2	2 1/8	2 3/8	5/16	3	2 1/4	3/16	2 5/16	1/8
1 9/16	2 3/16	2 3/4	3/8	3 1/8	2 3/8	3/16	2 7/16	1/8
1 5/8	2 1/4	2 7/8	3/8	3 1/4	2 3/8	3/16	2 7/16	1/8
1 11/16	2 5/16	2 7/8	3/8	3 1/4	2 3/8	3/16	2 9/16	1/8
1 3/4	2 3/8	3	3/8	3 3/8	2 3/4	3/16	2 9/16	1/8
1 13/16	2 9/16	3 1/8	1/2	3 3/8	3	1/4	2 13/16	5/32
1 7/8	2 5/8	3 1/4	1/2	3 3/8	3 1/8	1/4	2 15/16	5/32
1 15/16	2 11/16	3 3/8	1/2	3 3/8	3 1/4	1/4	2 15/16	5/32
2	2 3/4	3 1/2	1/2	4	3 1/4	1/4	3 1/16	5/32

* When using dogs as illustrated in Fig. 11, the dimensions in these columns are omitted.

shoulder without any recess of the kind shown at *A*, Fig. 12 The dimensions for such a shoulder as would be the result if the head of the bushings were made to the dotted lines apply to such bushings as are used with a dog, as shown in Fig. 11. In this case the dimensions in columns *I* and *K* in the table are omitted.

Table IV gives dimensions for bushings for holes which are reamed with a rose chucking reamer, after having first been drilled with a drill 1/16 inch smaller than the diameter of the reamer with which the hole is finally reamed out. The bushing to the extreme right, over the table, is the lining bushing, which is made of machine steel, case-hardened and ground. The bushing to the extreme left is the bushing for the rose

chucking reamer. It is made of cast iron and ground. The bushing in the center is the drill bushing which is made from tool steel, hardened and ground, or in cases where it does not seem warranted to make the bushing of tool steel, of machine steel, case-hardened and ground.

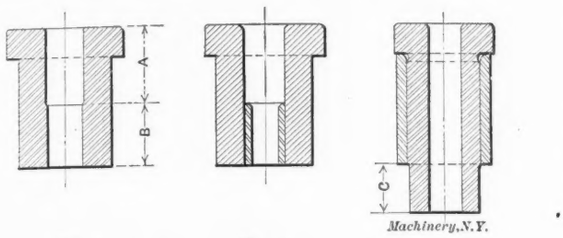


Fig. 15. Fig. 16. Fig. 17.

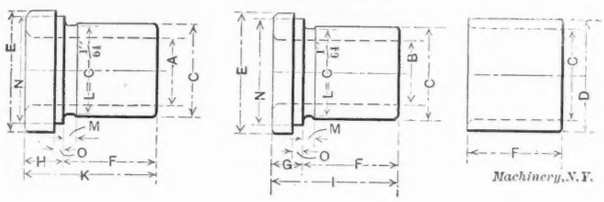
Special Types of Drill Jig Bushings.

The tapered removable bushing shown in Fig. 13 is objectionable on account of being expensive to make, and also on account of its liability to be thrown out of true by chips, etc., getting in between the outside of the bushing and the hole.

Screw Bushings.

Sometimes removable bushings are threaded on the outside and made to fit a tapped hole in the jig, as shown in Fig. 14. The lower part of the bushing is usually turned straight, and ground, in order to center the bushing perfectly in the hole in the jig. The head of the bushing is either knurled, or milled hexagon for a wrench. When these bushings are used they are, as a rule, not used for the single purpose of guiding the cutting tool, but combine with this the purposes of

TABLE IV. BUSHINGS FOR HOLES REAMED WITH ROSE CHUCKING REAMERS.



A	B	C	D	E	F	G	H	I	K	M	N*	O*
⅜	11/16	1 1/4	1 5/8	1 1/2	1 1/4	3/16	1/4	1 7/16	1 1/2	1/8	1 3/8	1/16
13/16	15/16	1 5/16	1 11/16	1 5/8	1 5/16	3/16	1/4	1 1/2	1 9/16	1/8	1 1/2	1/16
7/16	13/16	1 3/8	1 3/4	1 3/4	1 3/8	3/16	1/4	1 5/16	1 5/8	1/8	1 5/8	1/16
15/16	7/8	1 7/16	1 13/16	1 7/8	1 7/16	3/16	1/4	1	1 11/16	1/8	1 3/4	1/16
1	15/16	1 1/2	1 7/8	1 3/4	1 1/2	1/4	5/16	1 1/16	1 3/4	1/8	1 3/4	1/16
1 1/16	1	1 9/16	1 15/16	1 7/8	1 5/8	1/4	5/16	1 1/8	1 13/16	1/8	1 7/8	1/16
1 1/8	1 1/16	1 5/8	2	1 7/8	1 11/16	1/4	5/16	1 1/16	2	1/8	1 7/8	1/16
1 3/16	1 1/8	1 11/16	2 1/8	2	1 3/4	1/4	5/16	2	2 1/16	1/8	1 7/8	1/16
1 1/4	1 3/16	1 13/16	2 5/16	2 1/8	1 7/8	5/16	3/8	2 1/16	2 1/8	1/8	2	1/16
1 5/16	1 1/4	1 15/16	2 7/16	2 1/4	2	5/16	3/8	2 1/8	2 3/16	1/8	2 1/8	1/16
1 3/8	1 5/16	2	2 1/2	2 1/4	2 1/8	5/16	3/8	2 3/16	2 1/4	1/8	2 1/8	1/16
1 7/16	1 3/8	2 1/16	2 9/16	2 3/8	2 1/4	5/16	3/8	2 1/4	2 5/16	1/8	2 1/4	1/16
1 1/2	1 7/16	2 1/8	2 5/8	2 3/8	2 1/4	5/16	3/8	2 5/16	2 3/8	1/8	2 1/4	1/16
1 9/16	1 1/2	2 3/16	2 11/16	2 1/2	2 3/8	5/16	3/8	2 3/8	2 7/16	1/8	2 3/8	1/16
1 5/8	1 9/16	2 1/4	2 3/4	2 5/8	2 1/2	5/16	3/8	2 7/16	2 1/2	1/8	2 3/8	1/16
1 11/16	1 5/8	2 7/16	3 1/16	2 3/4	2 3/4	7/16	3/8	3 1/8	3 1/16	1/8	2 5/8	1/16
1 3/4	1 11/16	2 1/2	3 1/4	2 7/8	2 3/4	7/16	3/8	3 1/4	3 5/16	1/8	2 3/4	1/16
1 13/16	1 3/4	2 9/16	3 3/8	3	3	7/16	1/2	3 7/16	3 1/2	1/4	2 13/16	3/16
1 7/8	1 13/16	2 5/8	3 1/2	3	3 1/8	7/16	1/2	3 9/16	3 5/8	1/4	2 13/16	3/16
1 15/16	1 7/8	2 11/16	3 5/16	3 1/8	3 1/4	7/16	1/2	3 11/16	3 3/4	1/4	2 15/16	3/16
2	1 15/16	2 3/4	3 3/8	3 1/8	3 3/8	7/16	1/2	3 13/16	3 7/8	1/4	2 15/16	3/16
2 1/16	2	2 15/16	3 9/16	3 1/4	3 1/2	1/2	5/8	4	4 1/8	1/4	3 1/4	3/16
2 1/8	2 1/16	3	3 5/8	3 1/4	3 1/4	1/2	5/8	4	4 1/8	1/4	3 1/4	3/16
2 3/16	2 1/8	3 1/16	3 11/16	3 3/8	3 3/8	1/2	5/8	4 1/16	4 1/4	1/4	3 3/8	3/16
2 1/4	2 3/16	3 1/8	3 3/4	3 3/8	3 3/4	1/2	5/8	4 1/8	4 1/4	1/4	3 3/8	3/16
2 5/16	2 1/4	3 3/16	3 13/16	3 1/2	3 3/4	1/2	5/8	4 3/16	4 3/8	1/4	3 1/2	3/16
2 3/8	2 5/16	3 1/4	3 7/8	3 5/8	3 7/8	1/2	5/8	4 1/4	4 1/2	1/4	3 5/8	3/16
2 7/16	2 3/8	3 5/16	4	3 5/8	4	1/2	5/8	4 5/16	4 1/2	1/4	3 5/8	3/16
2 1/2	2 7/16	3 3/8	4 1/8	3 3/4	4 1/8	1/2	5/8	4 3/8	4 5/8	1/4	3 3/4	3/16
2 9/16	2 1/2	3 7/16	4 1/4	3 7/8	4 1/4	1/2	5/8	4 7/16	4 5/8	1/4	3 7/8	3/16
2 5/8	2 9/16	3 1/2	4 3/8	4	4 3/8	1/2	5/8	4 1/2	4 3/4	1/4	4	3/16

* When dogs illustrated in Fig. 11 are used, dimensions in these columns are omitted.

locating and clamping the work. For such purposes they are quite frequently used. These bushings are not commonly used as removable bushings, as it would take considerable time to unscrew, and to again insert a bushing of this type into the jig body.

Sometimes bushings for guiding the tools may be made of cast iron, but only in such cases when the cutting tool is of such a design that it does not have any cutting edges in the bushing itself, as, for instance, in the case of guiding the smooth surface of a boring-bar, or the shank of a reamer or a rose reamer, but hardened steel bushings must always be used when the cutting tool is liable to cut the bushing, as, for instance, in the case of drills and reamers, guided on their flutes, taps, etc.

Special Designs of Guide Bushings.

When the guide bushings are very long, and consequently would cause unnecessary friction in their contact with the cutting tools, they may be recessed, as shown in Fig. 15. The distance *A*, of the hole in the bushing, is recessed enough wider than the diameter of the tool, so as not to bear on it. The length *B*, being about twice the diameter of the hole, gives sufficiently long guiding surfaces for the cutting tool, to prevent its running out. If the outside diameter of the bushing is very large, as compared with the diameter of the cutting tool, as indicated in Fig. 16, the expense of making the bushings may be reduced by making the outside bushing of cast iron, inserting into this a hardened tool steel bushing, driven in place. The steel bushing is then given dimensions according to Table I for stationary bushings. The reason why there may be a necessity of a bushing having so large an outside diameter and so small a hole, may be that the bushing is required to be removed for counterboring part of the small hole being drilled, by a counterbore of large diameter, in which case the hole in the jig body has to be large enough to accommodate the larger sized counterbore.

If a loose or removable bushing is longer than the lining bushing, as illustrated in Fig. 17, it will prove advantageous to have the diameter of the projecting portion of the bushing about 1/32 inch smaller in diameter than the part of the loose bushing which fits the lining bushing. This lessens the amount of surface which has to be ground, and, at the same time, makes it easier to insert the bushing, giving it, so to say, a point, which will first enter the lining bushing, and it interferes in no way with the proper qualities of the bushing as a guide for the cutting tool.

In some cases, the holes in the piece to be drilled are so close to one another that it is impossible to find space for lining bushings in the jig. In such a case, it will be necessary to make a leaf, or a loose wall, or the whole jig of machine steel or tool steel, hardening a portion or the whole jig thus made.

* * *

MACHINE SHOP PRACTICE.

MACHINING A FIXTURE CASTING.*

MACHINERY'S articles on shop practice aim to supply, in a comprehensive way, definite, practical information about the various methods and operations chiefly comprising the work of the machinist; and while such instructions are always necessarily more or less elementary in character, and intended primarily for the apprentice, they are invariably interesting and valuable to the more advanced workman. We select, as examples, those operations which are general in character and best serve to teach the methods employed in actual practice, and the underlying principles of machine shop work; and in following this policy the information is of the greatest value to the largest number.

In Fig. 1 is shown a drawing of a milling machine fixture casting which is to be machined as indicated by the finish marks *f*. In this article we shall only discuss the planing operations, the boring and milling work being reserved for the next installment. In the Shop Operation Supplement accompanying this issue we have given condensed instructions for performing the planing operations, together with diagrams showing how the work is set up on the machine. Before setting this casting up on the table of the machine, it is first necessary to determine which of these surfaces shall be machined first. In general, when there are several surfaces on a piece of work to be machined, the shape of the work, and the relation of the finished surfaces to each other, must be considered in determining which part of the work is to be machined first. The fixture casting which we have selected as an example of

* With Shop Operation Sheet Supplement.

planing, boring, and milling work, is to have the bearing planed, which includes facing the top, planing the pillow-block cap fitting and facing the ends; the base with its tongue-piece, which is to be at right angles to the pillow-block cap fitting, planed; the top surface of the arm *H* planed; a T-slot milled in it, and the bearing bored. The T-slot *C* is to be parallel with the tongue-piece *B*, and the finished surface of the arm parallel with the base. Either the bearing or the base might be planed first in this case, but it is preferable to begin with the bearing, as the casting can be supported better on the rough base than on the unplaned bearing end. The first illustration on the Shop Operation Supplement shows the work set up for the first planing operation. Small parallel pieces were inserted beneath each corner of the base, as shown, in order to get a better bearing by preventing the casting from bearing on any high spot. If the base of the casting, because of its roughness, does not rest on all four parallels, liners of brass or tin should be inserted. In order that the base be of uniform thickness, its top surface should be set parallel with the table by using a surface gage. As the first planing operation consists of facing the top of the bearing and planing the fitting *G* for the pillow-block cap, and as this bearing is to be at right angles to the long side of the base and the T-slot *C* in the arm *H*, it will be necessary to set the casting with reference to these points. Inasmuch as the arm *H* is

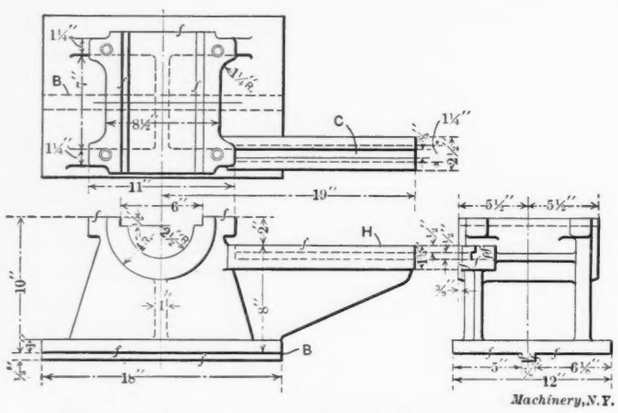


Fig. 1. Elevations and Plan of Milling Machine Fixture Casting.

considerably above the base, a straight-edge *A* is first set at right angles to the side of the table, as shown in the Supplement, and clamped in position. When the base is set parallel with the straight-edge, the cored slot in the arm may be tested by placing a square against the straight-edge and measuring from the blade of the square to the T-slot *C* at two points as far apart as possible. If the T-slot is not parallel, the casting should be shifted slightly so that both T-slot and base are as near parallel with the straight-edge as possible. The tongue-piece *B*, which is to be at right angles to the bearing, should also be approximately parallel with the straight-edge, so that when the casting is turned over and the base planed, the tongue-piece will true up. It is well to remember that in setting up any piece of work having a number of surfaces to be machined, that it should be so set that all surfaces can be finished in their proper relation to one another. After the casting is set it should be clamped firmly to the table, and set-screw plugs or other suitable stops set against it to prevent it from shifting when taking a cut. When planing the top surface *F* of the casting, the amount of metal to be removed will depend upon the distance between this surface and the base, and the required thickness of the base.

By locating the center *c* of the boss and the arcs *d*, and then working to these lines when planing the cap fitting, the fitting is made central with the boss. Obviously, the projection on the cap should also be planed central with its boss, so that when the cap is bolted in place the bosses and lugs on both castings will match each other.

When planing the base, the casting is inverted, as shown in Operation Sheet No. 62. As the tongue-piece *B* and the cap fitting are to be at right angles to each other, set the cap fitting at right angles to the side of the planer table by using a square as shown. As it is somewhat difficult to see the square blade when it is against the fitting, a piece of paper inserted between the square blade and fitting at each end of the fitting will aid in determining when the work is correctly set, as then both paper strips will be pinched by the square blade. When planing the base, roughing and finishing tools, similar to those shown at *A* and *B*, Fig. 2, may be used. The importance of removing the right amount of metal when planing the top of the bearing, will now be understood; if too much metal be removed, the casting will not finish to the dimension *H*, while if too little be removed, the flange of the base will be made too thin when the casting is machined to this dimension.

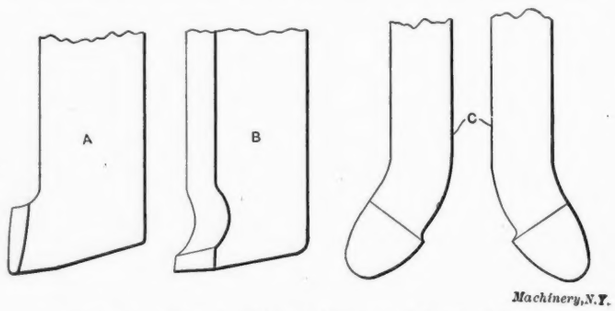


Fig. 2. Roughing, Finishing, and Right- and Left-hand Tools for Vertical Cuts.

Before planing the ends of the bearing, the drilling and tapping for the cap bolts should be done, and the cap bolted in place. The casting is then set up on the planer table, as shown in Operation Sheet No. 63, with the tongue-piece *B* against one side of a T-slot. In this way the casting is set so that the finished ends of the bearing will be parallel with the tongue-piece. Before taking a vertical cut on a planer, the nuts *D* (Fig. 3) should be loosened, and the top of the apron *E* swung away from the plane of the surface to be planed, so that when the tool rises on the return stroke, instead of rubbing against the surface of the work, it will swing away from it or in a plane indicated by the line *F*—*G*. Of course, when planing the opposite end of the bearing, the apron must be swung in the opposite direction. Right and left round-nose tools for facing the ends of the bearing are shown at *C*, Fig. 3. When clamping the tools in place for these vertical cuts, they should be set so that a continuous cut can be taken over the entire surface to be planed.

When it is desired to plane surfaces at an angle to a line perpendicular to the platen, the bolts *H* are loosened, and the planer head *J*, which is mounted on a swiveling base *K*, is set to the required angle by the graduations provided. In this case, as the ends of the bearing are to be at right angles to the base, the head is set to the zero mark. If the planer has been in use for a considerable time the zero mark may not be absolutely correct, and it is advisable to test the accuracy of the work by the use of a square.

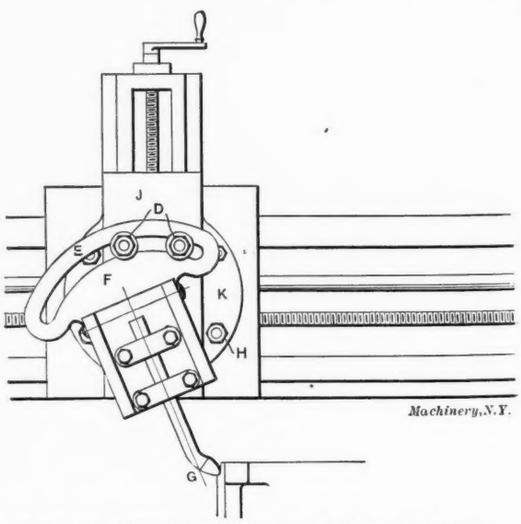


Fig. 3. The Planer Tool-block set for Taking Vertical Cuts.

LETTERS UPON PRACTICAL SUBJECTS.

TWO-JAWED LATHE CHUCKS.

The accompanying engravings illustrate the best two-jawed chuck for general use that the writer has ever seen. It has been made by the Mueller Mfg., Co. Decatur, Ill., exclusively for this company's own use. The chuck was designed by Edward Marcille and patented as long ago as January, 1889, but as the original patent has now run out, and as the Mueller Mfg. Co. does not make these chucks for the market but simply for shop use, a description of them and the manner in which they are made, may be of interest and value to the readers of MACHINERY. About fifty of these chucks

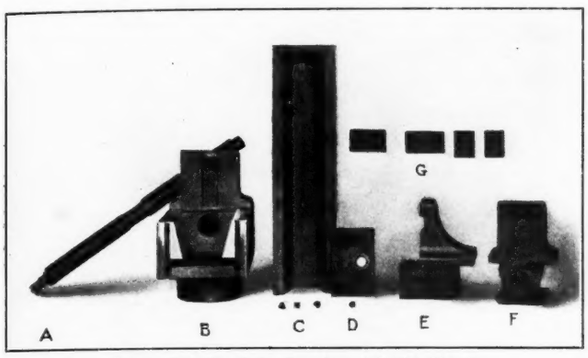


Fig. 1. Details of the Two-jawed Lathe Chuck.

are in use in the factory mentioned. Ten are used in the tool-room and about forty in the brass working shop. As a tool-room chuck, this design is unsurpassed for many jobs which formerly were done on the face-plate or on an angle plate. This is especially true in the case of core box work, where small metal core boxes are made for brass valve cores.

Some of these chucks, which have been continually in use for seven years, were recently overhauled, and showed very

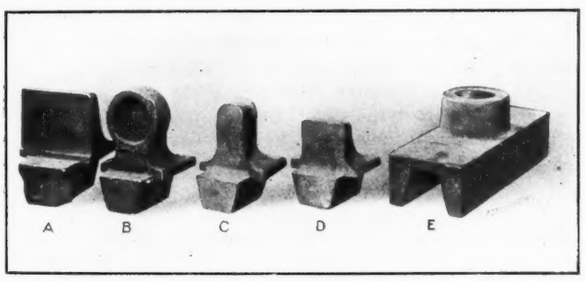


Fig. 2. Rough Castings used in making the Two-jawed Chuck.

little indication of the rough usage to which they had been subjected. The details of the chucks taken apart are shown in Fig. 1, in which *A* represents the chuck screw, threaded right- and left-hand, as usual. At *B* is shown an end view of the chuck, with the end-plate removed and one jaw in place. The part shown at *C* is a front view of the chuck body with everything removed, excepting one end-plate, the other end-plate being shown at *D*. A side view of the chuck jaws is

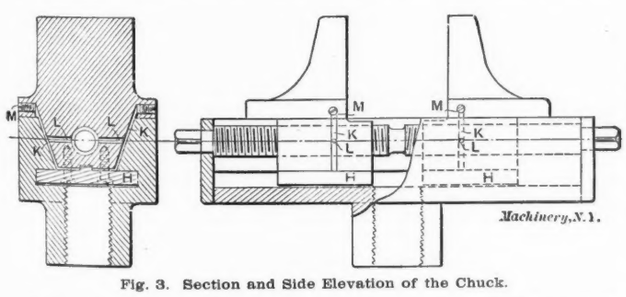


Fig. 3. Section and Side Elevation of the Chuck.

shown at *E*, and a front view is shown at *F*. It will be noted that these two jaws are grooved on their faces differently from the one shown at *B*. This is done in order to permit the holding of special false jaws, but most of the chuck jaws are grooved lengthwise of the jaw face. Finally, at *G* are shown small metal plates used to protect the chuck screw from chips and dirt.

In Fig. 2 is shown a group of the rough castings used for making these chucks. The castings shown at *A* and *D* are for regular jaws of different sizes, while those shown at *B*

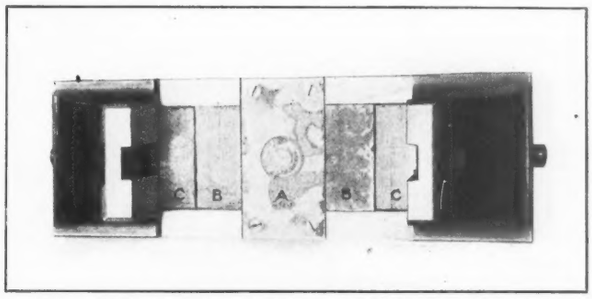


Fig. 4. View of Chuck with Jaws opened to Maximum Capacity.

and *C* are for special chucks. The casting for the chuck body itself is shown at *E*. The engraving Fig. 3 shows a section and a side elevation of the chuck. The section is taken at such a place as to illustrate the way in which the chuck is oiled, and the manner in which the jaws are set into the body and held. A plate *H* is screwed to the bottom of the

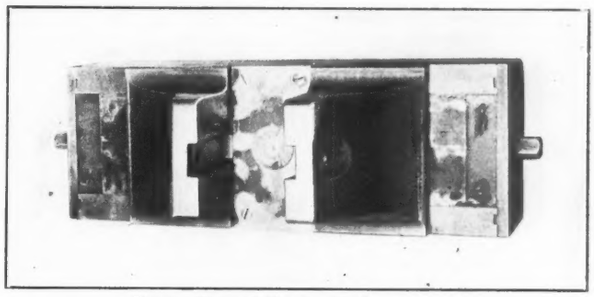


Fig. 5. View of Chuck with Jaws closed.

jaw, and fits into slots in the chuck body as shown. In regard to the oiling arrangement, oil grooves leading down the sides of the jaw are shown at *K*, while oil holes running in to the chuck screw nut are shown at *L*. At *M* are shown small screws for plugging up the oil holes. In the side elevation, part of the chuck is shown in section, to show the oiling arrangement. The half-tone Fig. 4 shows the chuck with the jaws open to their maximum capacity, and illustrates the

Fig. 6. Several Forms of Cast False Jaws used with the Chuck.

way in which the plates shown at *G* in Fig. 1 slide in and out and thus keep the chuck screw covered, excluding chips in a most effective manner. The plate *A* is stationary, and is held in place by screws. The plates *B* are made to slide in small grooves cut in the sides of the chuck body, and telescope in and out with the movement of the jaws by means of small pins working in the slots. The circular spot in the middle of plate *A* is an "accident." The parts *C* are projections of the jaws. In Fig. 5 the jaws are shown closed, and it is seen how the sliding plates at the back of the jaws are working, covering up the chuck screw in the same manner as the sliding plates in the front of the jaws.

As will be readily seen, these chucks are all intended to be used with false jaws, and an inspection of the construction will show how simple the chuck is, and how easy it is to take up the wear, on account of the beveled slot in the body,

and how rigid the long bearing of the jaws permits them to be. The location of the oil holes and grooves keep the working parts thoroughly oiled, being so placed that it is only necessary to take out the plug set-screws and inject some oil, the centrifugal force taking care of the rest. In the toolroom, flat false jaws are usually employed, but in the factory

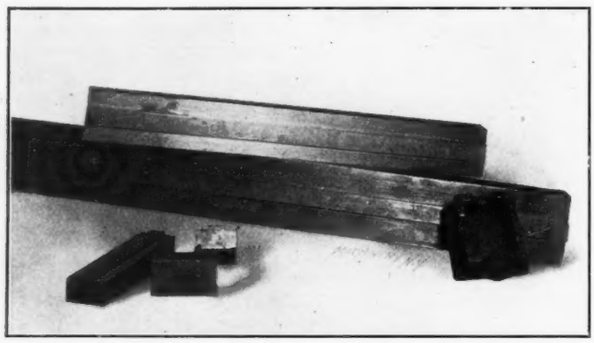


Fig. 7. Steel Bars from which Pieces are cut for making False Jaws.

special shapes are made for holding the different forms and sizes of valves being machined. The false jaws are made to fit the groove in the chuck jaws, and are held by a strong screw, and are interchangeable for any chuck of a given size. In Fig. 6 are shown groups of castings for several forms of false jaws, but most of the false jaws are made from machine steel bars and case-hardened. The bars are planed in long

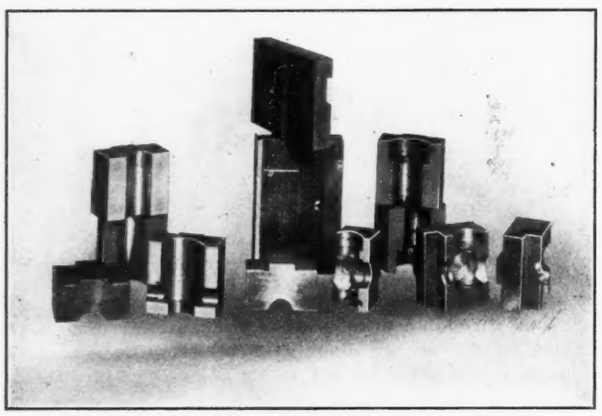


Fig. 8. Partly Finished False Jaws which were cut from the Pieces shown in Fig. 7.

sections, as shown in Fig. 7, and the pieces are cut off when needed and machined to whatever shape is required. In Fig. 8 some of these false jaws made from machine steel, and partly finished, are shown.

Special angle plate clamps, which are used to hold the chuck jaws when performing the various operations through which they pass on the shaper, are shown in Fig. 9. These

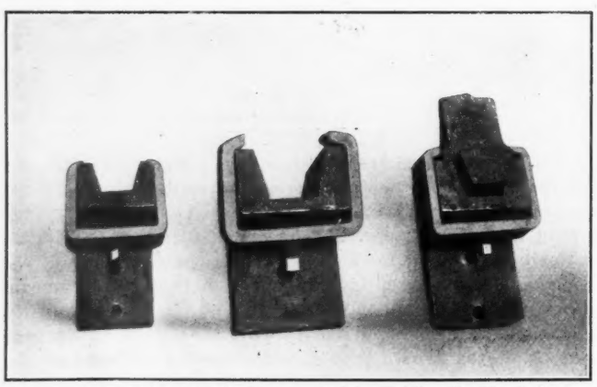


Fig. 9. Special Angle Plate Clamps used for Holding the Chuck Jaws when machining them.

appliances are also used on the lathe face-plate, to hold the jaw while the thread is being cut for the chuck screw. Finally, in Fig. 10 is shown a square block screwed onto the lathe spindle, and the chuck jaws screwed up to it. After the chuck jaws and all working parts have been carefully scraped and fitted into place, the assembled chuck is clamped by means of its jaws onto this block, and the threads in the body cut and the boss finished. These angle plates and the block mentioned are the only jigs or special tools used for making these chucks.

ETHAN VIALL.

Decatur, Ill.

TO MAKE ACCURATE ARBORS.

An arbor, to be an efficient tool, should have a true cylindrical surface, and have center holes that are exactly coincident with the axis, round, true as to angle, and perfectly smooth. The most important of these requirements is the center hole, as it is easily deranged. An arbor can be very easily ruined in a few seconds by letting one of the center holes get dry and roughen. The shape or design of a center hole is a

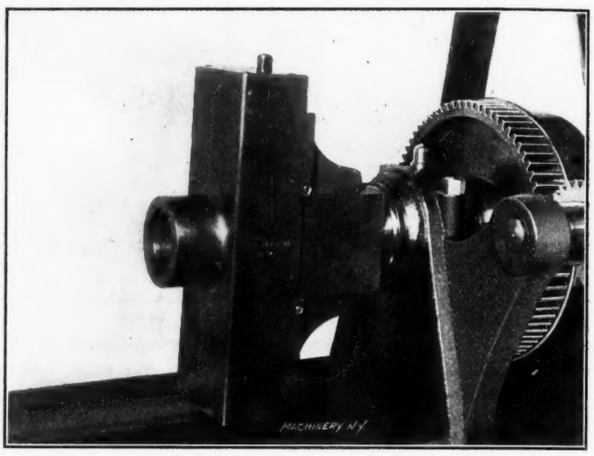


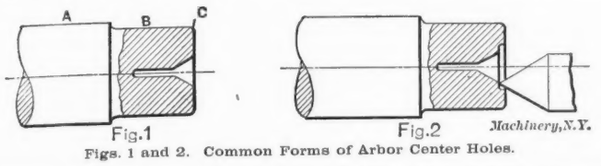
Fig. 10. The Way in which the Chuck is held when cutting the Thread and finishing the Boss.

factor that must not be looked upon as unimportant, though it is largely a matter of choice. The center shown in Fig. 1 is reamed to standard angle and the corner is rounded off at the mouth, while the center illustrated in Fig. 2 is reamed to standard angle and the end of the arbor counterbored. The advantages claimed for the latter are, protection of the center hole, and that it will stand considerable driving without spoiling the center hole, but then, driving is rather a barbaric practice. If by chance the arbor shown in Fig. 2 should get caught by the lathe center near the center hole, the point of the center is liable to raise a small burr, or chip out a small piece at the edge of the center hole. With the center shown in Fig. 1, this is prevented by the center striking the curved edge of the hole, and sliding into place. If the point strikes back of the curve it will be too far from the center hole to do any damage.

When making arbors the stock is cut first to length, and then carefully centered so that there will be a uniform amount of stock removed from all sides of the piece. This is important because of the difference of density caused by the rolling operations. After taking a roughing cut over the pieces, it is advisable to pack anneal them. This is to give any internal strains which were caused by the stock being straightened cold after being rolled, a chance to adjust themselves. After annealing they may be turned down, leaving the part *A* (Fig. 1) large enough to allow for grinding. This allowance will depend upon the length and size of the arbor. The possible spring of the stock in hardening must also be considered. The part *B*, with the curved edge *C*, may be turned to size and polished. Hold one end of the arbor in a true universal chuck, and run the other end in a steady rest. The curved edge of the center hole is now finished with a hand graver, and the end polished. The arbor is now ready for milling the flat places on the part *B* upon which the lathe dog is to be clamped. Procure a drill the size of the teat of the center drill used, and drill the center hole to the depth of about ½ inch. This is to make a reservoir for the storage of oil to lubricate the center when in use.

We are now ready to ream the center holes. This is a very important operation, and one that cannot be rushed, for much

depends upon this part of the work. We will need a 60-degree center reamer, one having several flutes, preferred. These flutes should be honed so that they have smooth, keen edges. Grip the center reamer in a chuck so that it runs absolutely true and block the lathe spindle. Now flood one center hole of the arbor with lard oil, and support the other end on the tail center which has been carefully lined up with the live spindle. Ream out the center hole by slowly turning the



Figs. 1 and 2. Common Forms of Arbor Center Holes.

arbor by hand and tightening up on the tail center enough to make the reamer cut. Right here is the place to go slow. Take very light cuts at a slow speed and use plenty of oil. Ream sufficiently to clean up the center hole from the center to the edge of the curved mouth. After carefully reaming all the arbors, inspect them to see that the burrs caused by the milling have all been removed, and that all the other operations have been done properly. The arbors are now ready to be hardened. If the hardening is done with care, the majority of them will be fairly straight. Large arbors may be left hard, but arbors below ¾ inch should be drawn, so that they will not be so liable to break.

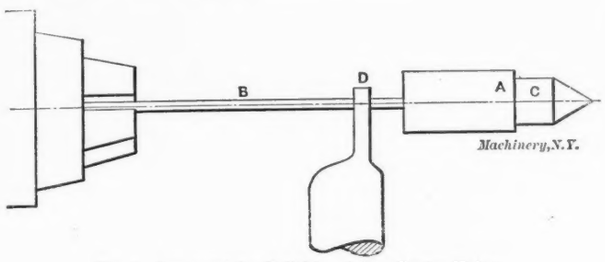


Fig. 3. Lap used for Polishing Arbor Center Holes.

The first operation after hardening is to pickle off the scale, after which the center holes are lapped. An accurate center hole is the most important part of an arbor, and to get this, it must be carefully finished. Brass laps seem to work very well, and as the lap has to be of correct shape to get a true hole, it is advisable to make up a quantity of them, so that the temptation to continue using a lap which is worn out of shape will be removed. The lap should be gripped in a small chuck or holder, and run at a very high speed. A speed lathe with a lever feed is excellent. If the lathe is not provided with a lever feed, remove the tail-stock cap so that the spindle can be moved in and out very easily by taking hold of the tail-stock screw. For the rough lapping use coarse emery. Drop a little coal oil in the center hole, and then sprinkle in a small amount of the emery. Support the other end of the arbor on a center in the tail-spindle and gently feed the arbor onto the revolving lap, removing it as soon as it touches the lap. Repeat the operation, and keep turning the arbor to neutralize any error that may exist in the alignment of the machine. It is important to do the lapping by instantaneous contacts with the lap to prevent the emery getting caught and ringing the center hole. It is much easier to keep the hole smooth, than to smooth it up after it is scored. Lap just enough to correct any distortion that may have been caused by the hardening. After rough lapping, change the lap, and with a finer grade of emery, re-lap the center holes to get them smoother, and to correct any errors that may have occurred in the roughing out.

To get the required polish, we will proceed as follows: Make a small brass cup *A* (Fig. 3) with a flexible steel shaft *B* about 4 inches long and 3/32 inch in diameter. With sealing wax, embed a small piece of oilstone *C* in the cup. Then rig up a small rest with a short bearing at *D*, about ½ inch back of the cup. The oilstone can be trued up with a diamond or piece of emery wheel, to the correct 60-degree angle. The object of the flexible shaft is to neutralize any chatter that may be caused by entering the lap in the center hole. This chatter, if not provided for, will cause the point of the oilstone to chip off. The rest is to keep the lap revolving in one plane. If this is not done, the lap revolving at a high speed is liable to go down through the shop if it by chance gets a little off center. Clean out all the center holes with gasoline to remove all emery, and insert the lap, using plenty of lard oil. Bear lightly on the lap to prevent it from getting dry and sticking, which would cause the point to break off. The oil stone will require truing up for every fifteen or twenty holes lapped, but considering the quality of work done, and the rapidity, it is a refinement well worth while. The lapping done, carefully test all the holes with a standard 60-degree plug, and mark all that will need to be lapped again to correct errors.

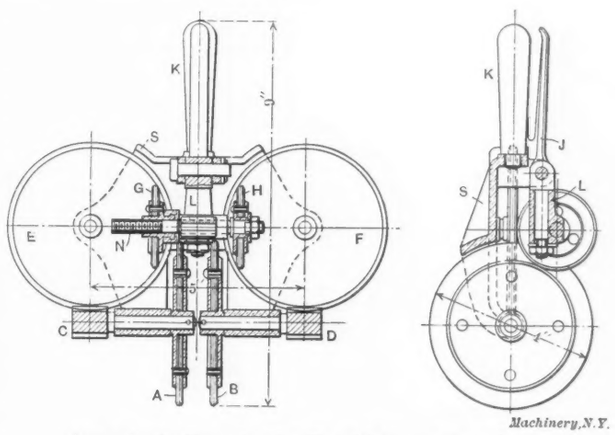
The last operation is to grind the cylindrical part. Because of the strains caused by the hardening, it is advisable to let the arbors season between the roughing and the finishing cuts. It will be found in some cases that they change shape after the roughing cut is taken. The arbor, if tapered, should have the number on the large end, and the amount of taper is governed by the length and the use to which it is to be put.

Lafayette, Ind. FOSTER HILLIX.

APPARATUS FOR MEASURING THE SLIP OF BELTS.

Belts slip under load a great deal more than is ordinarily supposed, and, for this reason, they are worn out much faster than is necessary, and at the same time the slip effects a great loss of driving power, so that a device which, under all circumstances, shows the amount of loss through slip, is of interest not only from a theoretical point of view, but also for its practical value. A simple and handy device for measuring belt slip is shown in the accompanying engraving. The device is held by the handle *K*, and applied in such a manner to the pulley on which the belt slip is to be measured that one of the two friction wheels *A* and *B* rests on the belt, while the other presses against the face of the pulley which projects outside of the width of the belt. The motion of wheels *A* and *B* is transmitted to the worm-wheels *E* and *F* by means of the worms *C* and *D*, of which one is right- and the other left-handed. From the worm-wheels *E* and *F* the motion is finally transmitted to the friction wheels *G* and *H*.

The hub of the wheel *G* is threaded on the inside so as to act as a nut on the threaded spindle *N*, which carries the other friction wheel *H*. When the belt is not slipping, the



Apparatus for Measuring the Slip of Belts; the Percentage of Slip can be read directly.

wheels *G* and *H* will run with the same speed, and will keep the same relative distance toward each other, but if the belt and the pulley investigated have different speeds, the spindle *N* will move outward toward the center of *F* in its nut *G*. until the friction wheel *H* will have moved so far inward in a radial direction on worm-gear *F* that its number of revolutions again equal those of *G*. The bracket *L* in which the shaft *N* has its bearing is provided with an opening in which a piece of glass is inserted. On this piece of glass a scale is provided, and the spindle *N* has a line cut at one place on its circumference, so that when the spindle moves in an inward direction the percentage of the loss through slipping

can be directly read off on the scale. The body *L* is connected with a lever *J*, which is mounted on a stud in the frame of the device, so that by pulling the lever towards the handle *K*, the friction wheels *G* and *H* may be disconnected from contact with the worm-wheels *E* and *F* at any time.

The appliance may be used for belts moving in either direction, and will show the correct result on the driven as well as the driving pulley, provided the device is applied correctly. It is, of course, necessary to always place the friction disk *B* against the part which is expected to run fastest, that is, in the case of driven pulleys against the belt, and in the case of driving pulleys, against the pulley. When correctly applied, the friction roller *H* and the spindle *N* on which it is mounted will, in the case of slip, move towards the center of *F*. If this is not the case, then the apparatus is not applied correctly, and should be turned around so that the proper friction disk works against the belt. The apparatus will also sometimes have to be put on the one side and sometimes on the other side of the pulley for which the belt slip is measured, in order that the scale on which the percentage of slip is read off may always be turned toward the operator of the device.

Pilsen, Austria-Hungary. MORITZ KROLL.

[The ingenious device shown and described above was designed by Prof. Kroll himself. His short and concise description hardly gives full justice to the ingenuity of this interesting device, but our readers will, no doubt, appreciate the simplicity of the mechanism by means of which the object sought is attained.—EDITOR.]

DIRECT FRACTIONAL-READING MICROMETER.

The direct fractional-reading micrometer, herein illustrated, is the result of talks with many mechanics in which all agreed that such a feature added to a micrometer would, by making it directly a fractional and decimal gage, more than double its practical value. While approximate readings in

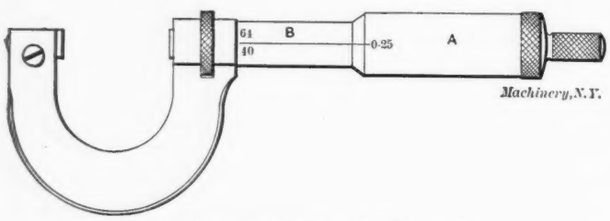


Fig. 1. Direct Fractional-reading Micrometer.

64ths, etc., may be obtained by the graduations on the hub *B* (Fig. 1) as on an ordinary inch scale, the exact readings of 64ths, etc., may be obtained only by reference to graduations on the movable thimble *A*. There are but eight places on *A* which coincide with the long graduation line on *B* when any 64th, 32d, 16th, or 8th, is being measured, and each of these eight places is marked with a line, and the 64th, 32d, 16th, or

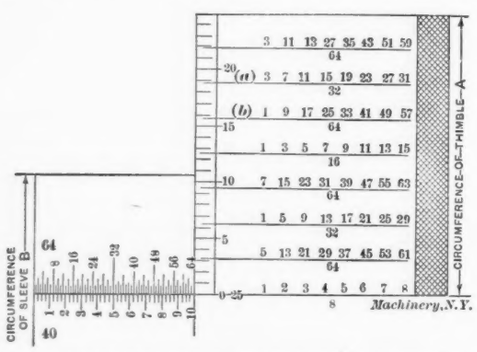


Fig. 2. Graduations on the Fractional-reading Micrometer.

8th for which that line should be used is marked thereon. See *a* and *b*, Fig. 2. The line *a* would be used for 3/32, 7/32, 11/32, etc., and the line *b* for 1/64, 9/64, 17/64, etc. Now suppose we wish to accurately measure 15/32 inch. We first roughly read it off the inch scale on sleeve *B* by turning out thimble *A*. Having secured it closely by drawing edge of *A* over that graduation, we find that the line *a* (Fig. 2) on the movable thimble very nearly or exactly coincides with the long graduation line on *B*. When these lines coincide, we have the exact measurement of 15/32 inch without reference to how many thousandths may be contained in the fraction. And so on through the scale any fraction may be found instantly. There is no mental arithmetic, use of tables, or memory work in using the tool. The new graduations are independent of the old, and may be used equally well with or without them.

Tools of various makes and sizes, which have been graduated, and are being graduated, differ from this in two re-

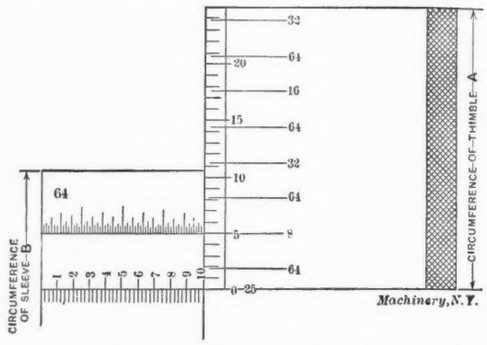


Fig. 3. Another Method of Graduating for Fractional Reading.

spects. Instead of using the zero line on *A* as a base line, a point is taken one-fifth of a turn around *A*, and the graduated scale on *B* is placed to correspond, as shown in Fig. 3; also, instead of making lines *a*, *b*, etc., on *A* full length, they are made about half an inch long, and the numerators are entirely omitted and the denominators placed at the end instead of under the line. To the ordinary user of the tool, this is all that is necessary for a perfectly clear reading of the fractions.

That this method of graduating is entirely new in principle and application, is proved by the very thorough search that was made in the patent office prior to the application, and further, by the fact that a broad patent has been allowed. To anyone having learned the use of micrometers, the new graduation appears, after one or two trials, perfectly simple, and they do away with all confusion as formerly experienced in reading fractions. CHARLES A. KELLEY.

Spring Lake, Mich.

THE CONFIDENCES OF A WORKMAN.

In the November, 1907, issue of MACHINERY there is an article on The Confidences of a Manufacturer which brings to my mind a little experience I had once, and incidentally I have learned that there is more than one kind of confidence. My title, which I received through promotion, was master mechanic. The place employed from 50 to 60 men, and some of the duties I performed were to look over the drawings that were made, and, as we did not employ a pattern-maker steady, take the drawings to an outside pattern-maker, and sometimes go personally and get the patterns and examine them. As our foundry deliveries were not regular, I sometimes carried the patterns to the foundry. (It might be well to mention here that the pattern-shop was about three miles in one direction, and the foundry about 4½ miles in another direction, by trolley.) I ordered all castings, and, as our patterns were returned each time they were used, I was obliged to get out the patterns, and when they were returned, check them all off, assort the castings, and place them in their proper bins. I also gave out the work to the men, looked after it, and often, with a new man, personally broke him in. I looked after all finished stock, and if a man was off a machine tool for a day, I was welcome to make use of it.

There was a constant cry from the management for better ways of doing the work, but if even a simple jig was suggested, it was stated that it would cost too much; if a fixture for some machine tool was suggested, the reply was, "Well, we haven't the time to make it," or "We cannot spare the machine as the machine has all it can do;" so, of course, the part would have to go back to the bench and be finished by hand. But even at that, when I did manage to make some

devices that were tried and liked, I would hear the old story repeated again. Then, in addition, when we made any new improvements in the machines we were building, of which I did a number, if it was a case for a patent, I made an assignment without any reward whatever. I also looked after all shafting and belting, motors, etc., made outside repairs to the buildings, looked after all the men's time cards, saw that they kept them straight, and I suppose did a number of other things that I do not recall just now—but I was supposed to enjoy the confidence of the management. When I went away, they called me "superintendent," but I didn't know it before.

MARS.

EXPANSION BORING-BARS.

There still seems to be room for the improvement of boring-bars. There are shown in the accompanying engravings two different types of bars, which I do not claim to be past improving upon, but nevertheless they have proved to be very satisfactory in many respects. About ten months ago I made the bar shown in Fig. 1, and gave it to the foreman of the boring mill department of the Colburn Machine Tool Company,

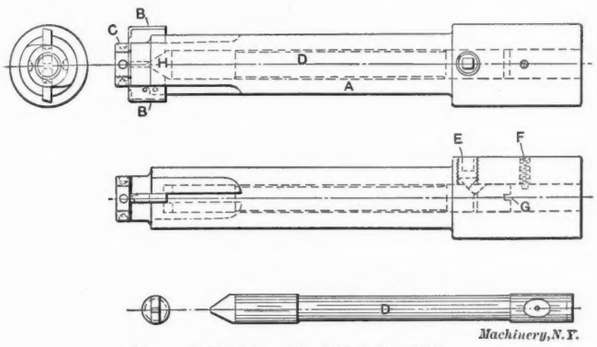


Fig. 1. Boring-bar with Adjustable Cutters.

by whom I was employed at the time as head tool-maker. He was very much pleased with it, and had me make up different sizes of cutters at once. The bar is still in good working order and does not show any great wear. A bar of somewhat similar construction, which was designed by one of the men under me, is shown in Fig. 2. This bar is a great deal cheaper and easier to make than the bar shown in Fig. 1, but does not prove so satisfactory in some respects. Referring to Fig. 1, bar *A* is made from a piece of machine steel. A hole for plunger *D* is drilled and reamed, the hole being bottomed out with a square-nosed drill. This may not seem practical, as in drilling long holes the drill is very liable to run off,

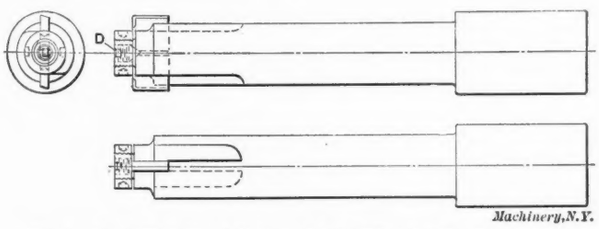


Fig. 2. Bar with Cutter Adjustment, but of Simpler Construction than the One shown in Fig. 1.

but in this case that does not make any material difference, as plunger *D* is all fitted in place before the cutters *B* are turned. Binder collar *C* is screwed firmly against the cutters *B*, and the bar is then put in the lathe and the cutters turned to size while in position in the bar. One cutter should be marked, so that each cutter can be placed back in the bar in the same position, making it impossible for them to be out of true, regardless of the location of the plunger hole. Binder collar *C* is made from machine steel, and case-hardened. The included angle of plunger *D* at *H* is 60 degrees. The maximum adjustment of the cutters is about 3/16 of an inch. This adjustment is accomplished by screwing the plug *E* against the conical surface of the plunger *D*, which forces the plunger against the cutters *B*, spreading them apart. Screw *F* is merely to keep the plunger from dropping out of place, in case screw *E* should be backed out too far. Screw-driver slot *G* is merely put in to aid in the assembling of plunger *D*. In setting cutters *B*, binder collar *C* should be tightened slightly by means of a spanner wrench, until after the cutters have been set to the proper size. One of the advantages that this bar has over the bar shown in Fig. 2, is that the adjustment screw *E* is always out of the way of the work and can easily be adjusted whether cutters be in the bore or out. The cutters of the bar shown in Fig. 2, are held in the same manner as in Fig. 1, but they are adjusted by means of the adjustment screw *D*, which is screwed in or out with a suitable wrench. One bad feature in connection with the bar shown in Fig. 2 is that the adjustment screw *D* sometimes jars loose and works out, but even then the binder collar *C* holds the cutters so firmly that I have never known them to move. These bars have both been in use on a 34-inch Colburn boring mill where there is lots of power to give them a hard test. The cutters used are made of high speed steel.

B. M. WELLER.

Franklin, Pa.

MAKING PISTON RINGS.

The method here described of making piston rings is used with good results in a shop building first class gas engines. A common ring blank having three lugs on one end is jig drilled, and secured with three cap-screws to a turning plate which has a number of tapped holes for the different size ring blanks. This turning plate is clamped to the chuck face with three clamps, and after the blank is turned outside, the plate is given one-half turn on a chuck bushing the plate end of which is turned 1/32 inch eccentric to chuck end. A stop-pin hole is drilled in the plate, which is used when the plate is revolved one-half turn after turning blank. The blank is then in position for boring. The bushing on which the plate turns is a driving fit in the bore of the chuck of a turret lathe (in this case a "Gisholt"), and this bushing is bored to take a stiff cutter bar. Two cutters are used in boring, one for roughing, and the other for finishing the bore of the blank to size. The bushing and chuck are marked plainly so that the bushing will always be driven in the chuck with the eccentric in the same relation with the stop pin hole in the turning plate.

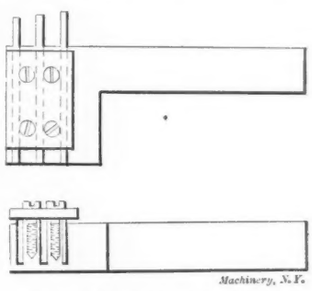


Fig. 1. Gang Tool for Cutting Off the Rings.

A gang cut-off tool is made, as shown in Fig. 1, and the rings are cut off 1/32 inch wide to allow for side finish. An expanding arbor (Fig. 2) and a straddle tool (Fig. 3) are used in facing the rings to size. A standard snap gage is used to keep the rings to a standard width. A straddle tool for each width of ring should be made so that readjusting on each size of ring will not be necessary. An almost incredible number of rings can be faced without regrinding when high speed steel bits are used. The expanding arbor plate *A* is secured to the face-plate of an engine lathe with three screws. The expanding sleeve *B* is held loosely to hub of plate by three screws *C*. These hold the expanding sleeve while drawing out the taper plug, and they also keep the bushing in the same position so that the ring to be faced will always

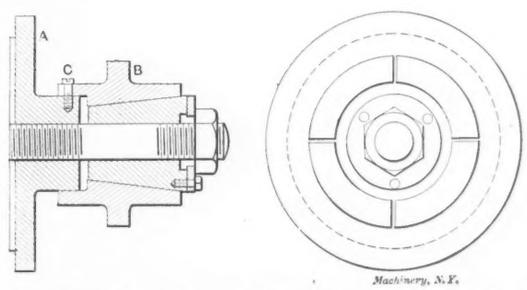


Fig. 2. Expanding Arbor for Holding the Rings while Facing them.

be central with the straddle tool. The sleeve is made in the usual way, one side being milled through with a milling saw, and a number of other slots being milled from both ends to within about ⅜ inch of the opposite ends. Almost any size sleeve can be made for this plate and arbor.

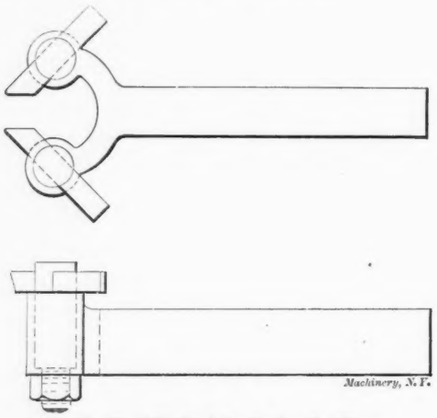


Fig. 3. Straddle Tool for Facing the Rings.

In Fig. 4 is shown the fixture used in milling the lap joint. The block *A* and clamp *B* are made to correspond with the outer and inner curvatures of the ring, the clamp having a flange to clamp down on the edge of the ring. The other end of the clamp is beveled to fit the block *C*. When the eccentric

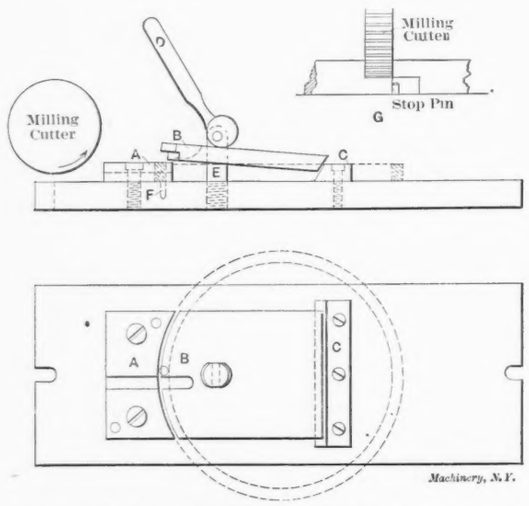


Fig. 4. Fixture for Holding the Rings when Milling the Lap Joints.

lever *D* is forced down, the clamp will hold the ring down and against the block *A*. The position of the ring is shown in Fig. 4 by the dotted lines. A coiled spring under the clamp *B*, and around the stud *E*, will raise the clamp so that the ring can be removed easily. After the rings are milled on

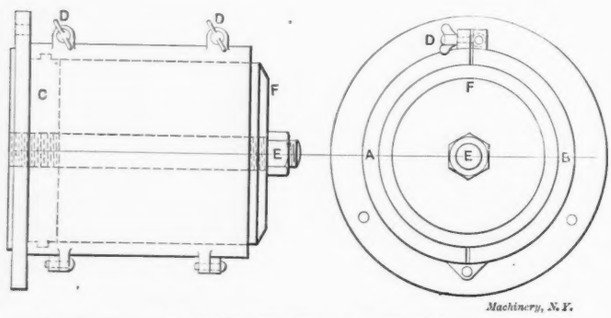


Fig. 5. Fixture for Holding the Rings when Finishing the Outside.

one side they are turned over, and the milled slot is set against a stop pin *F* which is inserted in the bottom plate. This stop pin sets the ring so that the cuts are taken as indicated at *G*, and a lap joint is formed when the rings spring together. A number of blocks and clamps can be made to use with rings of different sizes. The rings are now ready to be finished on the outside. The device shown in Fig. 5 is used in connection with this operation, and it is also secured to the face-plate. This device consists of a sleeve having two parts, *A* and *B*, these being connected with a hinged joint. The rings are placed inside this sleeve, and it is clamped to the plate *C* by the thumb screws *D*. The rings are then clamped to the plate by the nut *E* and plate *F*. The hinged sleeve is removed and the rings are turned to size.

Y. ZIEGLER.

TECHNICAL EDUCATION FOR MACHINISTS.

In this age of intellectual progress, one cannot help wondering at the comparative backwardness of the rank and file, engaged in mechanical arts, in acquiring technical knowledge pertaining to their vocations. Although technical knowledge is a rather broad term, it is generally applied to such knowledge as involves the fundamental and derived principles of any branch of industry, and upon which principles the evolution of any industry must be based. It can no longer be argued that the general lack of technical knowledge among machinists is due to absence of opportunity. Every large industrial center has institutions which offer every facility for technical education; and such facilities are in almost all cases available for persons for the mere asking, or at a minimum nominal cost.

It is manifestly impossible for every machinist to have had the benefits of a course of study in a technical school. Nearly every machinist starts to learn the trade at the average age of sixteen years. The knowledge he starts out with is rarely more than that acquired in the grammar school. Indeed, a canvass among the apprentices of any large plant would very likely show that not more than one-half have even graduated from the public grammar school or its equivalent. It is only in rare cases that a young machinist is found who is steadily pursuing a systematic course of technical study. Investigation will generally prove that those who do, have had the early advantage of better education, probably a few years in high school, which, no doubt, has given them the impulse to learn more.

In Greater New York, as well as in all larger cities, the Board of Education maintains a splendid system of evening schools of all grades. Here anyone can make up any deficiency in education due to lack of early opportunity. Instruction in these schools is absolutely free, including even the free use of text-books and supplies. The instructors are very often men who during the day teach in the best engineering and trade schools, and also men who hold important and responsible positions in the engineering professions. The correspondence schools also offer splendid opportunities for acquiring knowledge, although the scope of the knowledge they impart is necessarily somewhat limited on account of the impossibility of personal association between instructor and pupil. There are also the free public libraries whose shelves hold the best books on technical science. The Pratt Institute free library of Brooklyn has a splendid science reference room in which are kept current numbers of numerous industrial and technical periodicals, as well as complete reference libraries of every science and industry. This department could easily accommodate many times the number of persons who now regularly make use of it. It seems as though young men were needlessly starving in the midst of plenty. Although the democracy of education has been made practicable, how few there are who have thus far taken advantage of it. What valuable suggestions for mechanical improvement might come from machinists who can think with the precision acquired by a systematic course of technical training, and who have developed the capacity for keen observation during their daily work. Many large concerns have recognized the value of such training in their employes by maintaining regular schools, in which every apprentice receives, as far as practicable, a thorough technical training, aside from his regular shop instruction. In many cases these apprentices advance to responsible positions in these concerns. While it is true that the technical schools are graduating large numbers of young men as mechanical and electrical engineers, it is

equally true that these men are more or less handicapped by a lack of thorough shop training. The ambitious mechanic need not therefore fear much from the competition of college graduates if he is himself well equipped in technical knowledge. Of course, one cannot expect every machinist apprentice to become an expert mechanical or electrical engineer. There are, however, many men engaged in the trade who, if they followed their natural bent, and took advantage of some of the many educational opportunities, would develop into men who would eventually play an important part in the progress of the machine industries. F. WALSLEBEN.

Brooklyn Hills, L. I.

SIMPLE COST SYSTEM FOR SMALL SHOPS.

A great number of small shops, especially jobbing shops, use no cost system. It is then, very often, a part of the foreman's task to keep the record of the time and the materials needed to carry out the work. This may be easy to do when many of the same kind of pieces are required, but, when thirty men are working on several jobs, repair jobs for instance, the foreman's task may prove to be too heavy. It is obvious that under such conditions the exact cost and profit of a job are seldom known. The writer has had many occasions to note the big differences between the apparent and the real costs, and these differences indicated the necessity of a cost system even in the smallest shop. The one here illustrated was devised for, and has been for several years in use in, a jobbing shop employing about fifty men.

An order, Fig. 1. is sent from the office to the foreman for every job. Full details of the work to be done are given,

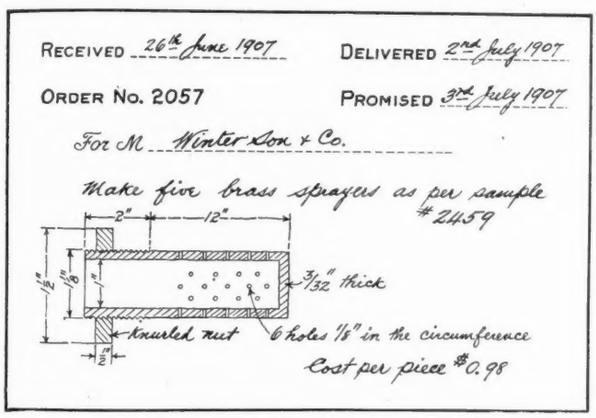


Fig. 1. Order for Foreman, giving Details of the Work to be Done.

indicating numbers of drawings, sketches or samples, if there are any, in short, everything that will furnish a ready reference in the future. The foreman notes in a special book the date order is received and the name and address of the customer. When the work is ready, he notes on the same line in his book the date of delivery. Every day the new orders are recorded, and the finished cancelled. Once in a month the whole is rewritten. Patterns, castings or special materials are ordered by the office according to the foreman's directions.

A shop order, Fig. 2, is given by the foreman to the workman for every piece or series of pieces to be made in the shop. All material wanted is applied for in the store-room. The storekeeper notes on the back side of the shop-card the kind and quantities of the materials used. When the work is finished the workman writes down, as shown in Fig. 2, his name, shop number, and the time devoted to the work.

The shop card, Fig. 2, was issued for the office order, Fig. 1, and a glance at both will show nearly everything in regard to the system. As will be seen, the work was first handled by the turner and then by the fitter. Finally a boy polished the finished sprayers, and delivered the work and the card to the foreman, who saw thus at a glance everything concerning the cost of the job. The net weight of material is marked upon the card which is then sent with the office order to the office, where special expenses and general charges are added. Finally, the cost and the date of delivery are marked upon the orders and they are filed.

Some orders require more than one shop card; for instance, to bore a 22-inch cylinder true, put new spring rings in the piston, true up the piston rod, and put new bronze bushing on the stuffing box. Four shop cards are then made, one for every part of the job, so that the cost of every detail is known. Nothing in the shop is done without an order, and not an hour is spent at a job without a shop card.

SHOP CARD

ORDER No. 2057 Iss'd. 29 June '07

MAKE

Five brass sprayers

DRAWING # TIME ALLOWED

SAMPLE # 2459

NAME	No.	PROFESSION	TIME HRS.	DATE, REMARKS
J. Brozen	12	Turner	5	28-VI.07
E. Peters	22	Fitter	3½	29 —
Callens	53	Apprent.	1¾	29. VI. 07

MATERIAL	RECEIVED	RETURNED	REMARKS
Brass pipe 1¼"	5 lbs. 11 oz.	2 lbs. 10 oz.	
Brass bar 1¼"	3 lbs. 2 oz.	2 lbs. 14 oz.	
Brass bar 1½"	15 lbs. 13 oz.	12 lbs. 11 oz.	
Solder ½	1 lb. 15 oz.	1 lb. 13 oz.	

NET WEIGHT 3 lbs. 14 oz. (5 pieces)

O. Pernet Foreman

Fig. 2. Workman's Shop Order on which Data are Recorded as shown.

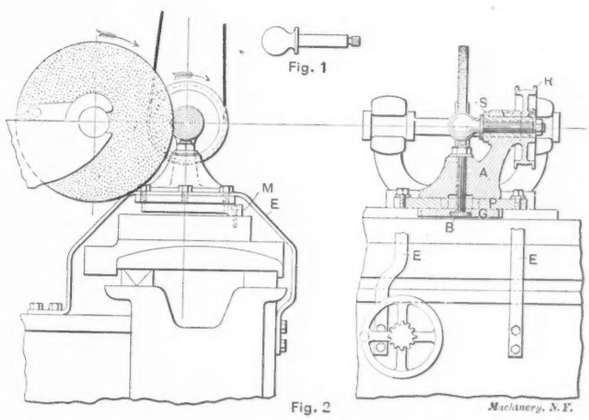
The management of the shop and the accountability of the business becomes much easier by the introduction of this system, which has proved to be quick, simple and economical.

Antwerp, Belgium. CHAS. ROELS.

BALL GRINDING FIXTURE.

Once, when employed by a firm engaged in the manufacture of printing presses, an occasion arose for making certain details, having a ball point as shown in Fig. 1 in the accompanying engraving. These balls had formerly been turned and then lapped with emery, but it was concluded that, by a proper fixture, these balls could be produced in a simpler way by grinding to the finished shape, after rough turning. The device shown was used on a Brown & Sharpe universal grinding machine.

Referring to Fig. 2, the frame *A* is made of cast iron, provided with a hole bored to receive the bolt *B*. The frame is recessed at the bottom to receive the hub of the gear *G*, and a



Figs. 1 and 2. Sample of the Work, and Fixture for Grinding the Ball Point on a Universal Grinder.

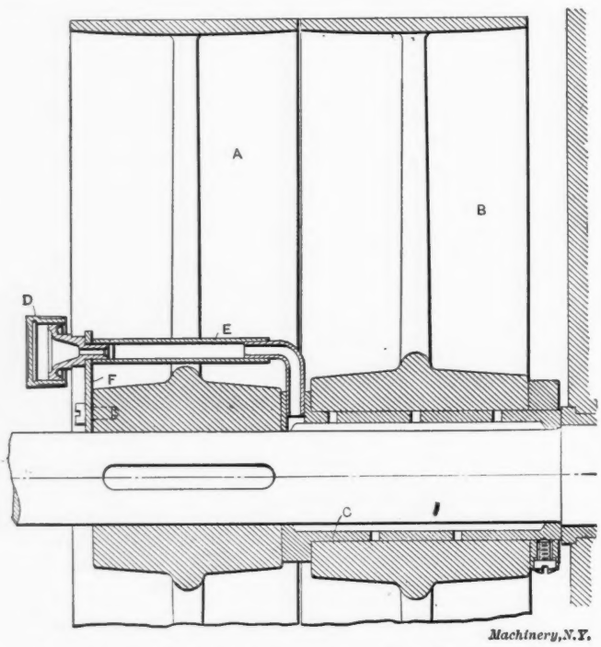
projection on the bottom of *A* is turned to a running fit in the cast iron plate *P*, upon which the fixture is mounted. A hole forming a bearing for the sleeve *S* is bored in *A* in the same plane as, and exactly at right angles to, the bolt hole *B*. A pulley *R* is mounted on the sleeve *S*, and keyed to it. This pulley is driven by a belt from an overhead pulley, causing the ball to revolve on its longitudinal axis. The wrought iron brackets or straps *E* are forged, and support the fixture. They

are bolted to the sides of the bed, and are set so as to allow a slight clearance between the spur gear *G* and the table of the grinder. The rack *M* is fastened to the table, and is in the right position to engage with the spur gear *G*, and as the table is driven back and forth it carries the rack with it, which drives the spur gear, producing a rotating motion for the frame *A*, causing the ball to rotate on its perpendicular axis. Now, as the ball rotates on the perpendicular axis and has a revolving motion on its longitudinal axis, it is plainly seen how the ball is ground. This fixture gave good satisfaction in the shop where it was used. W. A. SAWYER.

Athol, Mass.

DEVICE FOR OILING LOOSE PULLEYS WHICH ARE INACCESSIBLE FOR ORDINARY OILING DEVICES.

When a loose pulley is placed very close to the frame of the machine, as is the case with the loose pulley shown in the accompanying engraving, the question of oiling the loose pulley may offer difficulties, and in dusty places sometimes cause disturbances in the running of the machine.



Section through Tight and Loose Pulleys showing Method of Oiling.

The oiling of loose pulleys mounted in this way, however, can easily be accomplished by the use of the device shown in the engraving. The loose pulley *B* is mounted on a bushing, which in turn is keyed to the shaft. In this bushing an oil reservoir is provided which is connected with the inside surface of the bore of the loose pulley by a number of small perforations. The oil cup is fastened to the tight pulley on the side where there is no difficulty of access. The oil cup is then connected with the oil chamber in the bushing by a small bent pipe as indicated in the engraving. By arranging this oiling device on the drive of a vertical gang saw, the disturbances in operation, on account of the bearing of the loose pulley running warm, were entirely eliminated.

Pilsen, Austria-Hungary. MORITZ KROLL.

PUZZLING ARITHMETICAL EXPRESSIONS.

It seems as if the mathematical rules for simplifying an expression like $10 + 4 \times 5$ are not well known among mechanics. The general idea is to solve in succession, instead of regarding the manner in which the expression is connected by the signs, +, —, ×, and ÷. Mistakes are therefore commonly made. It surprised the writer to find that in a shop of about 300 men there were only two men who were sure that the correct answer to the expression $10 + 4 \times 5$ is 30, and this was in a shop with men of average intelligence. Most of the men got the result 70. The reason why the result of this expression is 30 instead of 70 is that the signs × and ÷ take precedence over + and — in mathematical calculations. However, in no text-books that the writer has been able to obtain has this rule been given in plain words, although all the examples have been worked out according to this rule.

New Britain, Conn. D. W. JAMES

[In order to make the expression containing the numbers and signs mentioned in our correspondent's example equal 70, it would be necessary to put a parenthesis around the expression $10 + 4$; that is, $(10 + 4) \times 5 = 70$. Otherwise, the multiplication should be carried out before the addition, and the result will be 30. If, instead of treating this little problem as an arithmetical one, we transform it into algebraic form, the reason for this rule is very obvious. If we substitute a for 10, b for 4, and c for 5, we have $a + b \times c$, or, as it is commonly written, $a + bc$. A glance at this expression shows at once that b is to be multiplied by c before the result of the multiplication is added to a. If it is required to add a to b, and then multiply by c, the expression would have to take the form $(a + b)c$. If we insert the mathematical values for a, b and c in these two expressions, we get 30 and 70 respectively, as before, and we have a valid mathematical proof, as well, for our rule.—EDITOR.]

LOCKING DEVICE FOR JIGS.

Quite often drill jigs have a bushing plate in the form of a leaf which swings on a hinge out of the way so that the piece to be drilled can be put in place in the jig. This requires a locking device which can be depended upon to hold the bushing plate exactly in place while drilling. The locking device shown in Fig. 1, and also shown applied to a jig

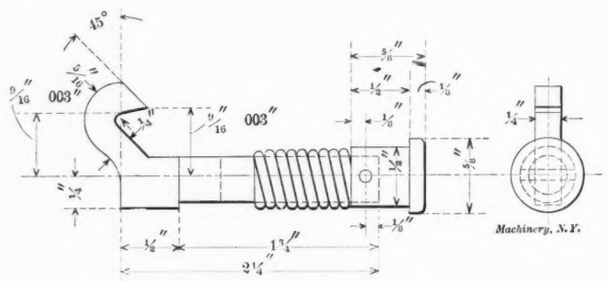


Fig. 1. Detail of Locking Device.

in Fig. 2, answers this purpose admirably, and after using a number of different designs I find the one shown here to be by far the best I have ever seen. To open the jig so as to put in the piece to be drilled, all that is necessary to do is to push the button on the end of the lock trigger and lift the leaf up. When the piece is in place in the jig, the leaf is again pressed down into place. The pressure springs the locking device, and the trigger grips the pin shown. The part

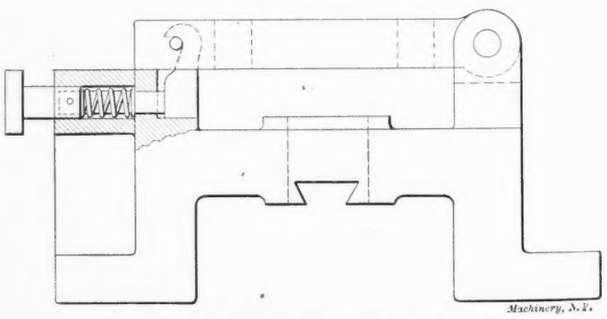


Fig. 2. The Locking Device applied to a Jig.

of the trigger which fits against the pin should taper slightly. This makes it hold much more tightly, and also takes up what little wear there may be on it. The device can be fitted to a great variety of jigs and fixtures. It is very simple and inexpensive to make, and above all, it is quick and simple to operate, positive in its action, and will last the lifetime of any jig without repairs. TOOL DESIGNER.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

SUBSTITUTE FOR STEADY-REST.

Under the head of "Shop Kinks" in MACHINERY I have a suggestion to make. A very good substitute for a follow-rest or steady-rest, and one which can be used in a great many cases where a steady-rest is troublesome, for instance on small shafts which are too long to turn without chattering unless a steady- or follow-rest is used, consists of a wooden block, say 4 inches square and of sufficient length to reach from the back side of the carriage to the shaft being turned. The block should bear on the shaft a little ahead of the cutting tool and its weight will prevent chattering to a very great extent. JOHN MCLEOD.

Birmingham, Ala.

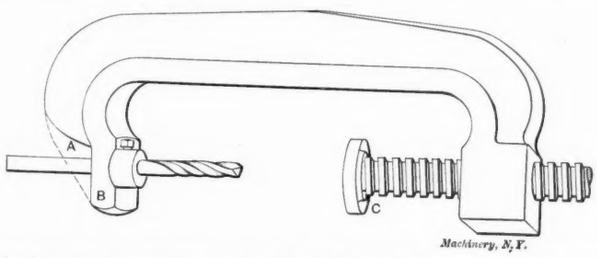
KINK FOR LINING.

I have seen several devices for section lining, but find the following very satisfactory: Take a bow pencil and set the needle point about one-sixteenth short of the pencil point, which should be sharpened to a chisel point; then set the bow pencil to the correct distance between the section lines wanted. Draw your first line with the pencil point next your triangle; your needle point will gage the width of lines and should not touch the paper but simply act as a guide for the eye. The bow pen can be used in the same manner. I do not claim this to be original, and some of the readers of MACHINERY may already be familiar with this method, but I have worked in some of the largest drawing-rooms in the country and have not known of this method being used.

TRIANGLE.

SIMPLE PORTABLE DRILL.

The quickest and simplest method of constructing a portable drill is by taking a large clamp, cutting out a part of the web, as shown at *A* in the accompanying engraving, and then drilling a half-inch hole through the upper jaw *B*, through which hole the drill may be passed. Then a collar with a set-screw is made, which is placed on the tool shank, the collar bearing against the inside of the upper jaw. For turning the



drill a chuck may be used with a bit stock, or a crank may be made provided with a set-screw for clamping the drill, which will serve the purpose equally well. The feeding is done by the clamp screw *C*. This style of drill may be used in numerous places where no other device could be applied; and if the clamp is wanted for clamping purposes, it may still be available for that purpose. G. M.

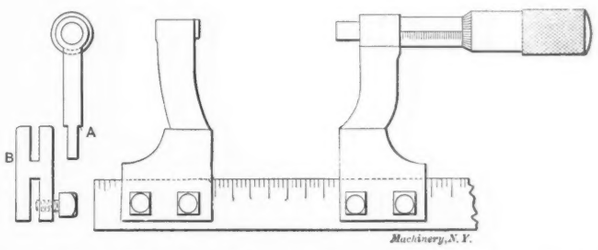
APPLYING LEATHER FILLETS TO PATTERNS.

It is very common to see a notice on the tags, attached to bundles of leather fillets, "Use plenty of good glue." Glue, however, is a bad thing to use for applying leather fillets to patterns, because the moisture from the wet sand penetrates the thin edges of the leather and makes them curl away from the patterns when glue is used. The best adhesive to use for leather fillets is the regular orange shellac used in varnishing patterns, excepting that the shellac used should be quite thick. A sufficient amount of fillet for the work in hand is given a coat of shellac on the inside, and the same is done with the corners of the patterns which are to receive the fillets. Repeat this operation about three times, allowing two or three minutes between the coats, so that the varnish may soak in. After applying the last coat, place the leather fillet in position and rub it into place with a round stick of suitable size to correspond to the radius of the fillet. Proceeding in this way, the result will be far more satisfactory than when using glue, and the fillet will be practically water-proof. J. W. WOLFENDEN.

Nashville, Tenn.

MICROMETER SCALE.

I have been using the micrometer, mounted as seen in the illustration, for some time, and I don't see how I could get along without it now. I use the micrometer on a 4, 6, 9, or 12-inch scale. It can be adjusted on standard plugs. I have made a set of gages up to 12 inches, out of 3/16-inch round tool steel wire. In mounting the micrometer, before cutting

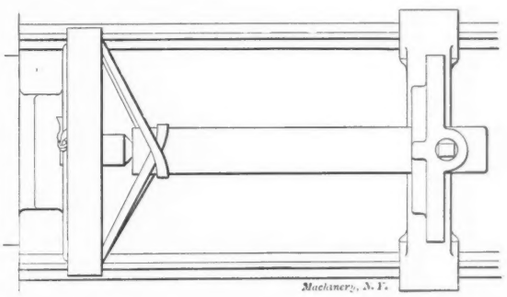


it apart, I milled the shoulders shown at *A*, and in milling the bottom pieces *B* used a piece of machine steel long enough for both, cutting the piece in halves after milling the slots. In this way I was sure of perfect alignment. In a shop where they do not keep a set of micrometers, this arrangement is very handy. WM. AINSCOUGH.

Plainfield, N. J.

USE OF THE STEADY-REST.

I have noticed that some men who claim to be tool-makers do not know how to make the best use of a steady-rest, and others seem to have very crude ideas about using it. A great many men use a chuck for holding one end of the work, even when it has centers in it. Of course, the work has to be trued up in the chuck, and this is a very difficult operation, although a very common one. A test indicator is almost indispensable for a job that requires accuracy. I never use a chuck unless the work is without centers. I always strap my work to the face-plate with a strip of belt lacing, and this method has proved very satisfactory. Two ¾-inch holes are drilled in the face-place at right angles to the driving-slot, and opposite each other. Then the work is placed between the centers, and the jaws of the steady-rest adjusted to it. The face-plate is then unscrewed a few turns, and the leather strap is wrapped around the work from one side, and the two ends of the strap passed through one of the holes in the



face-plate. One end of the strap is then passed back through the opposite hole in the face-plate and around the work from the other side. The ends are then tied together, and the face-plate is screwed onto the spindle, which causes the strap to tighten and draw the work against the center as shown in the engraving. Work can be done in this way accurately and quickly. I never use wooden or fiber jaws unless a steady-rest is equipped with them. If the work has a finish, a strip of emery cloth with the cloth side next to the work will protect it, and keep it from being marred. J. J. VOELCKER.

Decatur, Ill.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

DRILLING DEEP HOLES.

A. L. B.—What is the average time required for drilling small deep holes, say, from ¼- to ½-inch diameter and 20 to 30 inches deep, where special appliances are provided?

A.—The only drilling of this nature of which we have any record is gun barrel drilling, and the figures given below were taken from the records of a large concern, three or four years ago. Since then we understand the speed has been considerably accelerated, especially on 22-caliber barrels.

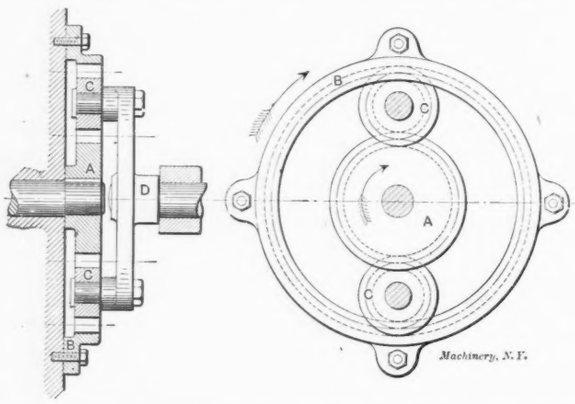
Caliber, inch.	Length, inches.	Time, minutes.	Driller's Daily Production.
0.22	24	48	120
0.32	24	34	130
0.38	24	24	140
0.44	24	24	140

The above figures are for low carbon steel. Nickel steel barrels require from 5 to 7 minutes longer.

EPICYCLIC GEARS.

L. A. F.—I desire to construct an epicyclic mechanism of the kind illustrated in the accompanying sketch. *B* is a stationary internal gear, *A* is the driving spur gear, and *C* two intermediates connecting *A* and *B*. These intermediates are mounted on pivots carried by disk *D*, which is keyed to the driven shaft. *A*, driving, makes 1,140 revolutions per minute; internal gear *B* has 62 teeth; how many teeth should gears *A* and *C* have to give *D* 690 revolutions per minute?

A.—A simple way to analyze a case of epicyclic gearing like this is to find, by the following method, how many revolutions *A* makes to one of *D*. In the sketch, *B* is shown held to the frame of the machine by cap screws. Remove these cap screws, and revolve the whole mechanism (with gears *A*, *B*



and *C* locked so that they do not turn on each other) in the direction of the arrow, for one revolution. This, of course, will revolve both *D* and *A* one revolution each. If the gears be now unlocked, and *D* be held stationary while internal gear *B* is revolved back again (in the direction opposite to the arrow) to the position it originally occupied, this movement will still further revolve *A* in the direction of the arrow, and will leave the mechanism in the same condition it would have been in had *B* remained fixed to the frame of the machine, and while *D* was revolved once in the direction of the arrow. If we can find, then, how many revolutions *A* makes in the operation we have just been through, we will know how many revolutions it makes for each revolution of *D* while the mechanism is in operation.

In the following analysis, these reference letters are used:

N_a = number of teeth in A
N_b = number of teeth in B
M_a = revolutions per minute of A
M_d = revolutions per minute of D

In revolving *B* in the direction of the arrow for one revolution with the gears locked, *A* evidently makes one revolution. In returning *B* to its original position with *D* locked, the number of revolutions *A* makes is evidently found by dividing the number of teeth in *B* by the number of teeth in *A*, since *C* acts merely as an idler under these conditions and does not affect the ratio. The sum of the two movements thus effected, gives the number of revolutions of *A* to one revolution of *B* when the mechanism is working. We have then

$$\text{revolutions of } A \text{, mechanism locked} = 1$$

$$\text{revolutions of } A \text{, returning } B \text{ to position} = \frac{N_b}{N_a}$$

$$\text{revolutions of } A \text{ to 1 revolution of } D = 1 + \frac{N_b}{N_a} \qquad (1)$$

The desired number of revolutions of *A* to one revolution of *D* is evidently found thus:

$$\text{revolutions of } A \text{ to 1 revolution of } D = \frac{M_a}{M_d} \qquad (2)$$

Making (1) and (2) equal to each other, we have the following equation:

$$\frac{M_a}{M_d} = 1 + \frac{N_b}{N_a}$$

This solved for N_a gives us $N_a \left(\frac{M_a}{M_d} - 1\right) = N_b$

$$N_a = \frac{N_b \times M_d}{M_a - M_d} \qquad (3)$$

which is the formula for finding the number of teeth in gear *A*, under the conditions proposed by our problem. Solving this formula for the figures given, we have

$$N_a = \frac{62 \times 690}{1140 - 690} = \frac{42{,}780}{450} = 95 +$$

which is evidently absurd, since it is impossible for *A* to have more teeth than *B*, the internal gear which surrounds it, both being of the same pitch. No mechanism of this sort will give *D* as much as half the number of revolutions per minute that *A* makes. The larger gear *A* is, and the smaller intermediate gear *C* is, the nearer 2 to 1 will the ratio be. It can be done by using compound gearing in place of *C*, but very likely you would not care to go to that extent of complication; otherwise the problem is impossible. In solving problems by this formula it should be noticed that the difference between the number of teeth in *A* and the number of teeth in *B* must be an even number; and that half this difference will be the number of teeth for each of the intermediate gears *C*.

JIB CRANES.

H. E. R. How should the stresses and sizes of the members for the crane shown in Fig. 1 be figured? The load is 5 tons. Members are to be built up of two channel irons each side, back to back.

A.—The calculation of the size of the channels is one of trial and error largely, and would occupy too much space to give here in detail, so we will simply give calculations showing the maximum stresses in the members we have selected as suitable for use in the case in question, after having tried various sizes. As shown in Fig. 2, it seems best to use 15-inch 33-pound channels for the yard arm, and 12-inch 20½-pound channels for the mast and brace. The channels forming the mast should be latticed. The calculations given below do not consider any of the minor factors which enter into the problem, such as the weight of the beams themselves, the weight of the trolley, and the pull of the ropes. These factors would appear to be amply taken care of in the margin of strength given by the channels selected. The designer, however, should always make sure of this.

The following table gives the properties of the shapes we will consider in our calculations:

Depth of channel in inches.....	15	12	10
Weight per foot in pounds.....	33.0	20.5	15.0
A = area of section in square inches	9.90	6.03	4.46
r = least radius of gyration.....	0.912	0.805	0.718
Z = section modulus, axis perpendicular to web.....	41.7	21.4	13.4

In addition to the reference letters given in the table above and in Fig. 2, the following will be used:

M = bending moment.
S_b = maximum fiber stress due to bending.
S_t = maximum fiber stress due to tension.
S = maximum fiber stress.

First find the maximum fiber stress due to bending at D in the yard-arm, when the load is at the extreme outer position E in Fig. 2.

$$M = Wc = 5{,}000 \times 60 = 300{,}000 \text{ inch pounds.}$$

$$S_b = \frac{M}{Z} = \frac{300{,}000}{41.7} = 7{,}200 \text{ pounds per square inch.} \quad (1)$$

Note that W is only half the total load, since each member of the structure is composed of two channels, one on each

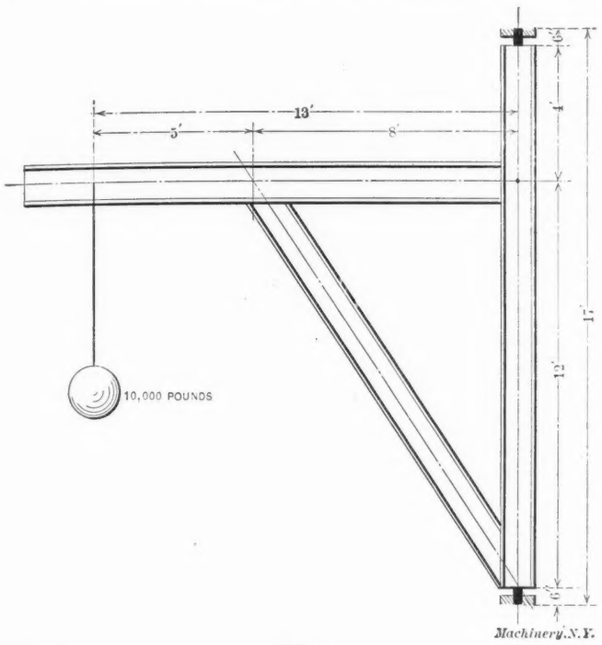


Fig. 1.

side. The bending moment at D when the load is at B is found thus:

$$M = \frac{Wl}{4} = \frac{5{,}000 \times 96}{4} = 120{,}000 \text{ inch-pounds.} \quad (2)$$

This being much smaller than in the previous case, it will give less than half the fiber stress. Unless there is some good reason for the design of framework adopted, it should be well to make ED about one-fourth of the length of DH. If this is done, the bending moment will be the same whether the load is at E or B, and, will in either case, be less than the maximum moment we have just found, so that a smaller section could be used.

The vertical reaction at D is found thus:

$$R_1 = W \times \frac{a}{l} = 5{,}000 \times \frac{13}{8} = 8{,}125 \text{ pounds.} \quad (3)$$

This produces a tensile stress in DH which may be found by the parallelogram of forces shown in Fig. 2, or by the following calculation:

$$R_3 = R_1 \times \frac{l}{g} = 8{,}125 \times \frac{8}{12} = 5{,}420 \text{ pounds.} \quad (4)$$

The stress per square inch in DH due to this force is:

$$S_t = \frac{R_3}{A} = \frac{5{,}420}{9.9} = 550 \text{ pounds per square inch.} \quad (5)$$

Adding this to the stress found in (1) we have the total stress in DH:

$$S = S_t + S_b = 550 + 7{,}200 = 7{,}750 \text{ pounds per sq. in.} \quad (6)$$

which is the maximum fiber stress in the yard-arm, occurring just to the right of point D. This is well within the limit of safety, which may be taken as about 13,000 pounds per square inch.

The allowable fiber stress in the brace may be calculated from the following formula based on Rankin's formula for columns:

$$S = \frac{15{,}000}{1 + \dfrac{e^2}{13{,}500 \times r^2}} = \frac{15{,}000}{1 + \dfrac{173^2}{13{,}500 \times 0.805^2}} =$$

3,395 pounds per square inch. ..... (7)

The reaction producing compression in CD is found by the force diagram in Fig. 2, or by the following calculation:

$$R_2 = R_1 \times \frac{e}{g} = 8{,}125 \times \frac{173}{144} = 9{,}760 \text{ pounds.} \quad (8)$$

The compressive stress per square inch in the brace is, then,

$$S = \frac{R_2}{A} = \frac{9{,}760}{6.03} = 1{,}620 \text{ pounds per square inch.} \quad (9)$$

which is, as may be seen, not quite one-half the allowable amount. The ratio of the length to the radius of gyration ($e \div r$) in this strut is so great, being about 215, that it is wise to keep the unit compressive stress down to a very low point.

The mast is most liable to fail by bending at H when the load is at E. To find the bending moment at H, we must first find the horizontal reaction at G:

$$R_4 = W \times \frac{a}{k} = 5{,}000 \times \frac{13}{17} = 3{,}825 \text{ pounds.} \quad (10)$$

The bending moment at H is then:

$$M = R_4 \times f = 3{,}825 \times 54 = 206{,}550 \text{ inch-pounds.} \quad (11)$$

and the maximum fiber stress due to bending at this point is

$$S_b = \frac{M}{Z} = \frac{206{,}550}{21.4} = 9{,}650 \text{ pounds per square inch.} \quad (12)$$

which is well within the limit of safety.

If the next size smaller standard channels had been used for these members, the results would have been as follows: A 12-inch 20½-pound channel for the yard-arm would give a

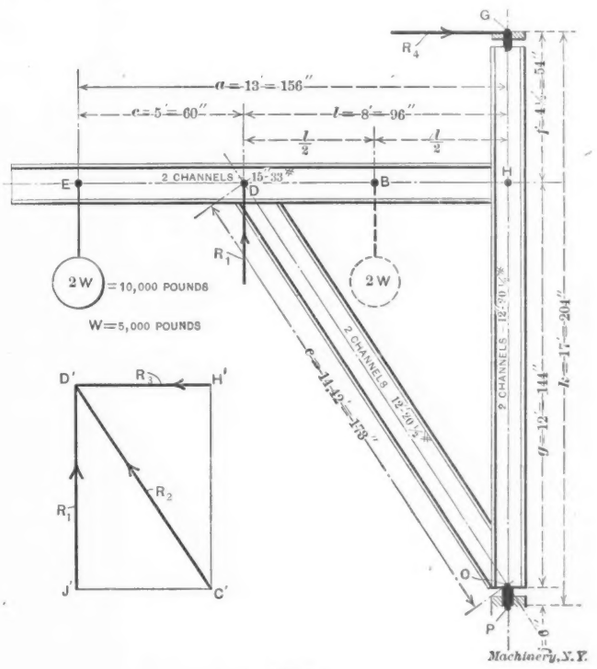


Fig. 2.

maximum stress at D of about 14,000 pounds, which is too much. The unit compressive stress in the brace, if made of 10-inch 15-pound channels, would be about 2,190 pounds. Rankin's formula for this would allow 2,830 pounds, but there is not enough margin of safety with the high ratio of e to r, which is here about 240. The maximum stress in the mast at H would be 15,400 pounds per square inch. It will thus be seen that the sizes we have selected are the commercial sizes best suited for the case in hand.

We expect to publish in a forthcoming issue of MACHINERY an exhaustive article dealing with jib cranes of this type, in which the matter will be taken up more thoroughly.

NEW MACHINERY AND TOOLS.

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP.

QUICK CHANGE GEAR DRIVE FOR THE QUEEN CITY SHAPER.

The Queen City Machine Tool Co., Cincinnati, Ohio, has recently designed a positive speed changing mechanism for their 20-inch back-geared shaper, to take the place of the four-step cone previously used. This device has been designed with especial care, so that it will be simple, durable, effective and easily operated. The builders believe that they have so far accomplished their purpose, that the purchaser who desires to avail himself of the manifest advantages of the geared drive, may obtain them without running the risk of meeting the deficiencies which are found in many mechanisms of this kind.

The mechanism will be understood by reference to Figs. 2 and 3, which show in detail the mechanism seen applied to the shaper in Fig. 1. The single speed driving pulley at the left of Fig. 2 is keyed to the gear box shaft, which runs clear through the column to the gear box attached to the frame on the opposite side. At the right-hand end it carries a friction clutch, operated by the handle shown. The operation

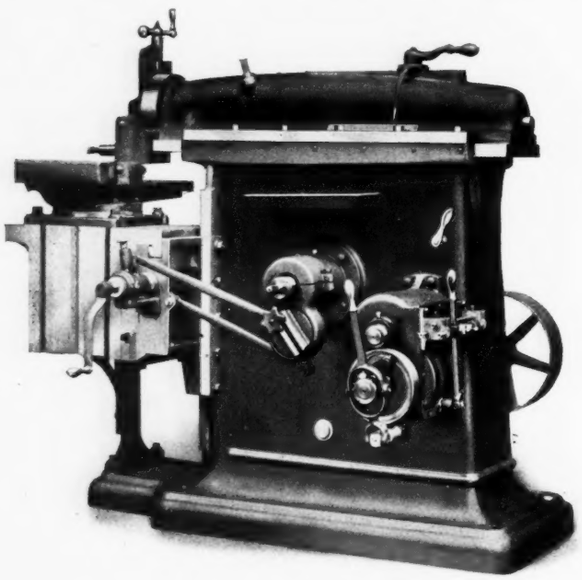


Fig. 1. Quick Change Gear Drive for Queen City Shaper.

of this clutch connects the shaft with a sleeve loosely mounted on it. It may thus be used for starting and stopping the machine, an overhead counter-shaft not being necessary.

The sleeve carries keyed to it a series of four gears of 21, 27, 32, and 38 teeth, respectively. On the driving shaft above the gear box shaft are keyed two sets of double gears, of 38 and 32, and 27 and 21 teeth, respectively. Though keyed to the shaft, these double gears are free to be shifted longitudinally, so that either one of the four gears in the sleeve may be engaged to its corresponding gear on the driving shaft, giving the latter the speed appropriate to the ratios of the driving gears in use at the time.

The mechanism for shifting the gears on the driving shaft is best seen in Fig. 3. The gear shifter lever is pivoted at the bottom on a universal joint, so that it may be moved in and out, or forward and back. Brackets attached to the rear of the gear box support the two sliding rods and the two fixed rods shown in the top view. When the gear shifter lever is tipped in toward the gear box, it lies between gear shifter No. 1 and the dog shown, both of which are fastened to sliding rod No. 1. The shifter lever may now be thrown toward the column or away from it, so that the 27- and 32-tooth gears may be engaged (see Fig. 2), or the 21- and 38-tooth pair. To engage the other set of gears, sliding rod No. 1 has to be brought to the central position shown, where it is held by a spring locking plunger; the shifter lever may then be swung past the fixed rods to operate sliding rod No. 2. The function of the fixed rods is thus to prevent the possibility of throwing two sets of sliding gears at once, by making it impossible to operate one set until the other has been moved to the neutral position. When the lever has

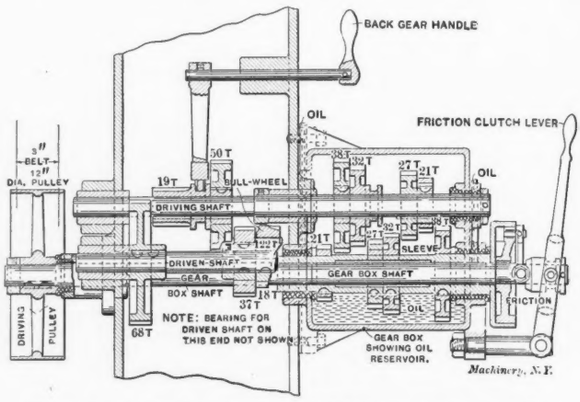


Fig. 2. Longitudinal Section through Driving Mechanism, showing Arrangement of Gearing.

been swung over to lie between the dogs on sliding rod No. 2, the gear shifter may be operated to bring either the 38- and 21-, or the 32- and 27-tooth combinations of Fig. 2 into action. The yoke shown, attached to a sliding rod No. 1, simply serves the purpose of preventing the rotation of that member, thus keeping gear shifter No. 1 in position, the yoke sliding freely on No. 2 for that purpose. Gear shifter No. 2 is kept in position from the fact that sliding rod No. 1 passes loosely through a hole in it, and thus supports it.

The four speeds obtained by the gear box are multiplied by two, giving eight in all, by the double sliding gear on the driving shaft inside the column, whose 19-tooth and 50-tooth members engage respectively with 68-tooth and 37-tooth gears, keyed to driven shaft shown, which also has keyed to it an 18-tooth pinion, engaging the bull wheel from which the ram

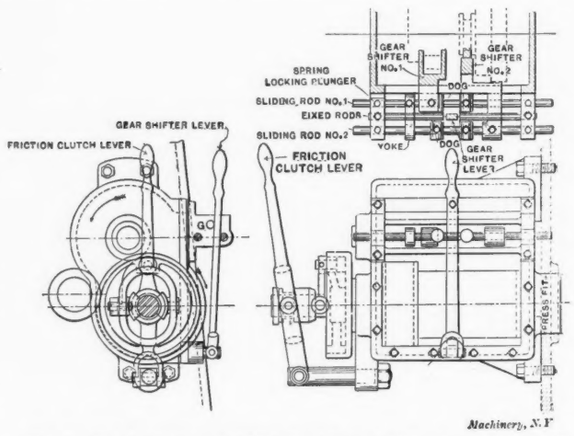


Fig. 3. The Arrangement of the Gear Box, and the Levers by which the Drive is Controlled.

is operated. This double gear is shifted, as plainly shown, by the back gear handle projecting through the side of the column.

The handles for stopping and starting the machines and making the eight speed changes are all located close together, as shown in Fig. 1, and the changes may be made almost instantaneously. The four gear box changes may be made in as many seconds. The clutch is disconnected for this purpose, so that the sleeve is free from the gear box shaft being driven by it only by the slight frictional contact of the bearings. The "selective" control, operated by the gear shifter lever, may then be used to obtain instantly any one of the

four speeds provided without going through the intermediate changes. The slow revolving of the telescopic sleeve permits the meshing of the gears at once, and since the load is off, no shock occurs, so that the change is as smoothly effected as with the cone pulley and the belt, although the power of the drive is very much greater than with the older arrangement.

The use in this mechanism of the principles which have become the standard for the automobile speed change devices will at once be recognized. The changes are made without the use of insecurely supported tumbler gears, or a multiplicity of clutches and levers. In the drawings, the clutches and all the gears are shown disengaged, and it will be noted that the length inside of the box is but slightly greater than the sum of the gear faces, so that the floor space required does not exceed that of a cone driven machine. The positive shifting of the gears and the arrangement of the rods, prevent the possibility of interference and insure safety and reliability. The gear box itself is a press fit in the column besides being firmly bolted to it. All parts are easily accessible for inspection without taking the box from the column. The gears all run in oil so that an efficient and durable action is assured.

When using a constant speed motor (for which this drive is especially suited) the changes can be made without stopping it. When the shaper pulley is belted to the line shaft, it should run at about 350 revolutions per minute on this size of machine. This gives cutting strokes of 7.2, 10.96, 15.4, 23.5, 34.8, 53.1, 74.7, and 114 per minute. An index plate aids in selecting the proper speeds.

EBERHARDT BROS. SMALL AUTOMATIC GEAR-CUTTING MACHINE.

Fig. 1 shows a front view, and Fig. 2 the rear elevation, of the smallest of the line of automatic gear-cutting machines made by Eberhardt Bros. Machine Co., 66 Union St., Newark, N. J. This newly designed tool resembles somewhat its

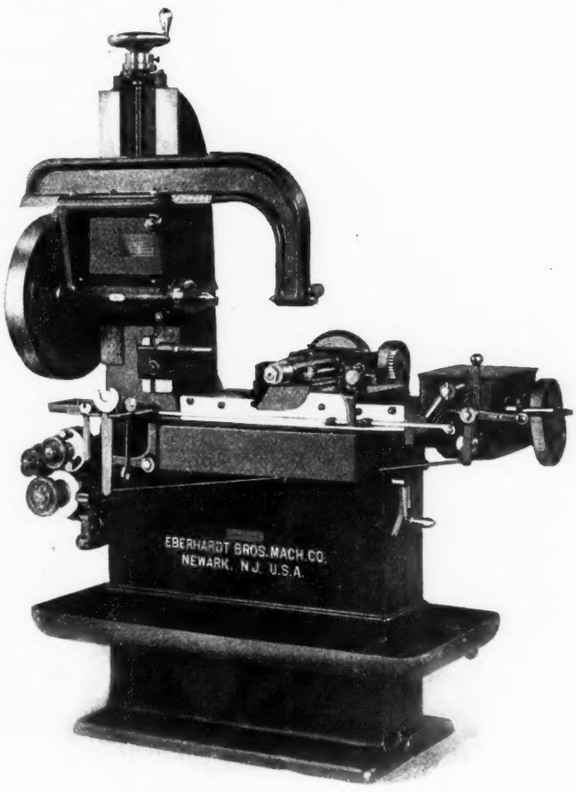


Fig. 1. Front View of Eberhardt Bros. Small Automatic Gear-cutting Machine.

predecessor, the combined spur and bevel gear cutting machine shown in "New Machinery and Tools" for July, 1907. The machine has the distinctive features of simplicity of construction and convenience of arrangement. These features are shown most prominently in the ribbed frame (see Fig. 2), doing away with the use of cores in the molding, and in the overhanging arm support provided for the work arbor. The result of these and similar provisions is an inexpensive and convenient machine for small work.

The machine is driven directly from the counter-shaft to the single speed tight and loose pulley shown in Fig. 2. This makes the use of a counter-shaft unnecessary. The indexing

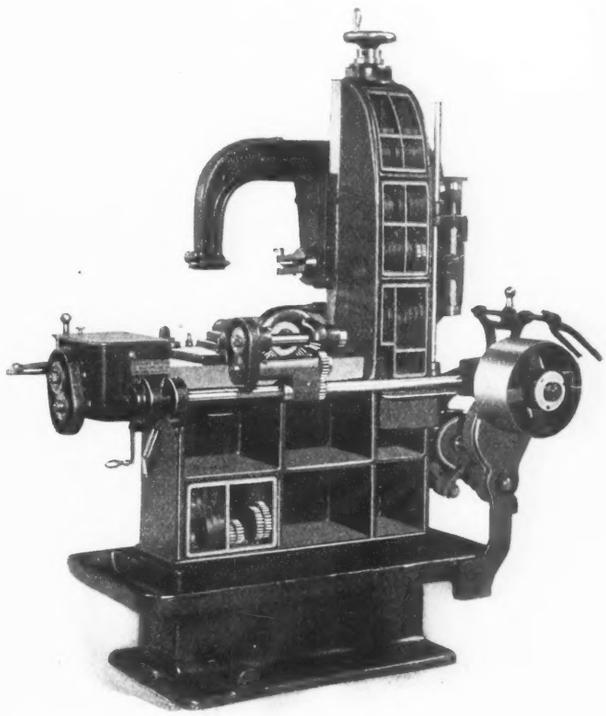


Fig. 2. Rear View of Machine, showing Spindle Drive, etc.

mechanism is connected to the shaft for this pulley by the gearing shown, while the cutter slide is driven through bevel gears and the long splined shaft running lengthwise of the bed. This splined shaft is geared to an intermediate shaft which is connected by change gearing (giving six rates of spindle speed) with the main bevel driving gear keyed to the spindle. This driving gear is of large diameter compared with the cutter, giving a strong, steady action to the latter.

The splined shaft from which the spindle movement is derived is continued forward to the feed box at the front of the bed, where is located the proper mechanism for automatically feeding the slide forward at a rate determined by the change gears provided (giving 8 changes) and quickly returning it at high speed to allow the work to be indexed and to commence a new cut. All these movements, as well as the control of the indexing, are positive.

The work arbors have tapered shanks, which fit the tapered hole in the steel work spindle. A bolt is provided at the rear of the work spindle for drawing in and forcing out the arbors without hammering. On most work, the overhanging arm shown is used to support the outer end of the work arbor. For work over 17 inches in diameter, for which the arm cannot be used, it is easily removed. A pair of centers and a dog driver are supplied, to be used for work similar to that of cutting a gear blank on a lathe mandrel, or the teeth of a pinion solid with a shaft.

This machine will cut gears as coarse as 8 diametral pitch in steel, or 6 diametral pitch in cast iron. It will thus be seen to be especially adapted to the cutting of change gears, and is used on this work in the shops of its builders, one machine being kept in continuous operation on change gears from 20 up to 6 diametral pitch. The machine is capable of being used for many odd jobs as well as for manufacturing, and has been especially designed to allow it to be quickly set up for work of various kinds. The operator can easily set the machine for any ordinary work in 15 minutes, and usually in much less time.

CINCINNATI AUTOMATIC GEAR-CUTTING MACHINE.

A new automatic gear-cutting machine of the orthodox type (such as shown in Figs. 21 to 28, in article entitled "Gear Cutting Machinery," engineering edition), has been placed on the market by the Cincinnati Shaper Co., Cincinnati, Ohio. Aside from the interesting points in the design and construction of this tool, which we will mention later, it is noteworthy from the fact that it is the first machine of its kind built in Cincinnati—a city which can claim to produce pretty nearly everything else required in the line of machine tools.

The main features in the design of this machine as may be seen in Figs. 1 to 4, are its simplicity and compactness, together with its rigid construction and the ease with which

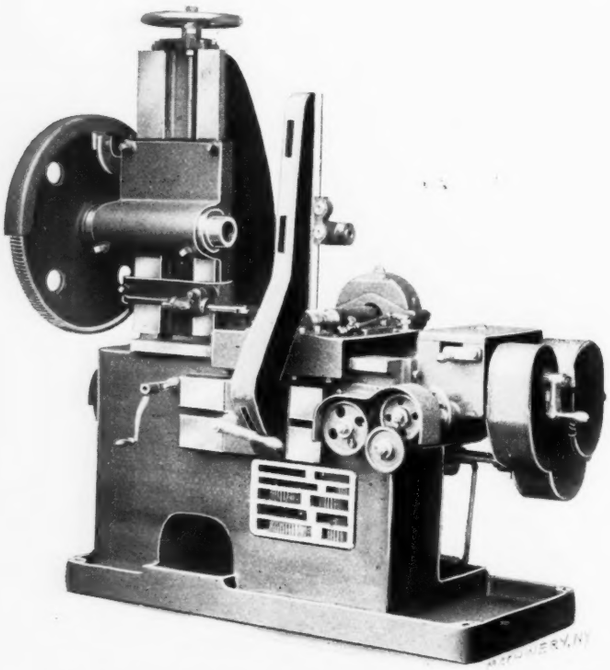


Fig. 1. Automatic Gear-cutting Machine made by Cincinnati Shaper Co.

it may be adjusted. The bed has been considerably shortened without decreasing the length of the cutter slide bearing, this being made possible by extending the cutter slide forward of the cutter spindle, so that it extends past the face of the column when at the forward extreme of its travel. It is gibbed with rectangular guiding surfaces instead of the usual dove-tail bearings, and has a long taper gib for taking up the wear. The same form of bearing and gib is used for holding the work saddle to the face of the column. In the case of both the work saddle and the cutter slide, the length of the guiding surface is much greater than its width, thus making any binding action impossible. This is particularly important in the case of the work saddle, since it prevents the work spindle and blank from dropping out of parallelism when the clamps are loosened for adjusting the work for the tooth depth. This fault, found in many gear-cutting machines, makes the micrometer reading of the screw practically worthless.

Both cutter and work spindles are of large diameter, are accurately ground, and are journaled in bronze bushings with provisions for taking up wear. The journal of the cutter spindle is adjustable endwise for centering the cutter to a gage furnished with the machine. The cutter spindle is driven by worm gearing provided with means for taking up the end thrust wear of the worm. The cutter end of the spindle has a No. 10 Brown & Sharpe hole for the cutter arbor, which is keyed to the spindle, and is drawn in or forced out by a threaded bolt. A removable bearing is provided for supporting the outer end of the cutter arbor.

All of the mechanism is driven from one single speed pulley *N* (see Figs. 3 and 4), the various changes for the feeds and spindle speeds, as well as the indexing, being obtained by change gears. Great care has been taken to provide short stiff shafts for the connections between the driving pulley and the spindle, so as to avoid torsional vibration in the members to which they transmit power. The driving pulley is connected by bevel gearing with a short shaft extending into gear box *O*. The swinging door, shown at the end of the gear box, in Fig. 2, covers the change gearing by which the desired spindle speeds are obtained. This change gearing gives six rates, ranging from 28 to 146 revolutions per minute. A splined shaft *P* leads from the change gearing through the worm carried by the cutter slide, thus driving the spindle. The drive, it will be seen, is simple and direct.

The gears for altering the feeds are mounted underneath the guard at the front of the machine in Fig. 1. They provide for ten changes, ranging from 1 to 7¼ inches per minute. Change gears for faster feeds can be furnished if desired. The feed of the cutter slide is effected by a screw, whose motion is controlled by positive clutches, operated by reverse lever *K*. The clutch for the quick return is cushioned to prevent undue shock. The feed motion and the indexing mechanism are so interlocked that it is impossible for the cutter to be fed forward until it has been indexed fully to its new position. All the movements have to take place in proper sequence, it being impossible for any one of them to begin until the succeeding ones have been completed.

An ingenious feature of the machine is best shown in Figs. 3 and 4. This is the arrangement for adjusting the dogs by which the movement of the cutter slide is limited and reversed. At the front of the bed are two shafts *A*, with ends squared for cranks. These are carried through to the rear of the machine where they are keyed to spiral gears *B* engaging mating gears *C* on screws *D*. These gears are keyed to the screws which thus turn with them, while still being allowed to move endwise through a limited distance. Stops *F*, *G*, and *H* are carried by screws *D*. Stop *F* is fixed as

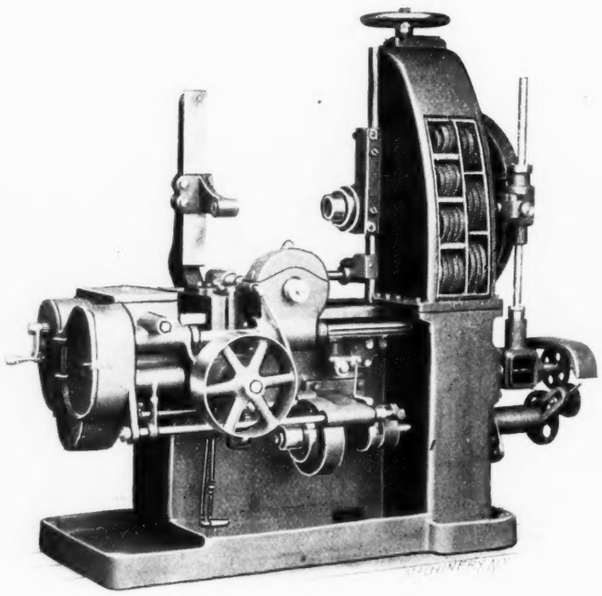


Fig. 2. Rear View of Cincinnati Gear-cutter, showing Driving Mechanism.

to longitudinal position on outer screw *D*, but allows the latter to revolve freely in it. Its inner end is supported by a slide screwed to the base of the machine, so that it thus helps to support both of screws *D*. Stop *G* is threaded on the inner screw, and slides loosely on the outer one, while stop *H* is threaded on the outer screw and slides on the inner one, as best shown in the upper detail view in Fig. 4. By this means the revolving of the left-hand shaft *A* adjusts stop *G*, while the revolving of the other adjusts stop *H*.

Tappet *E*, in the cutter slide, normally acts on stops *G* and *H* to reverse the motion of the cutter slide when it has reached either extreme of its travel. When striking *H* on its forward movement, it forces screws *D* to the left, thus moving spool *J*, which throws reversing lever *K*, returning the slide to its

forward position. Here the tappet strikes dog *G* which throws the spool *J*, and with it the reversing lever *K* in the other direction, starting the slide forward again on the feeding cut, though this is not allowed to take place until the indexing movement has been completed, as previously explained. By withdrawing pin *E* out of the reach of stop *G*, the return of the slide may be allowed to continue until *E* strikes fixed stop *F*, which is the extreme limit of the table movement in the backward direction. It is thus unnecessary to alter the adjustment when it is desired to run the slide clear back.

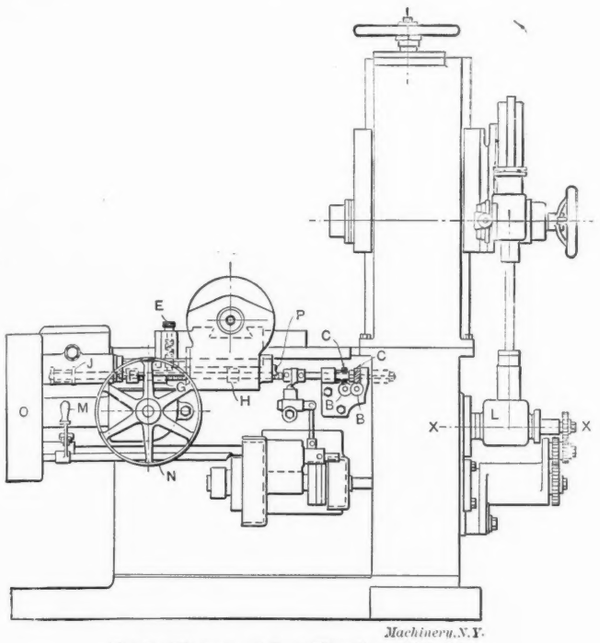


Fig. 3. Diagram of Rear Elevation of Machine.

This arrangement makes the setting of the stops possible from the front of the machine, and it is easily effected before the machine is started, by proceeding as follows: The cutter slide is run to the extreme forward position desired and then, by means of the crank, dog *H* is run against the tappet *E* until the reverse lever throws the clutch over to engage the reverse side. Then the cutter slide is run back by hand until the desired back position is reached, when dog *G* is run against the tappet until the clutch is thrown over to engage

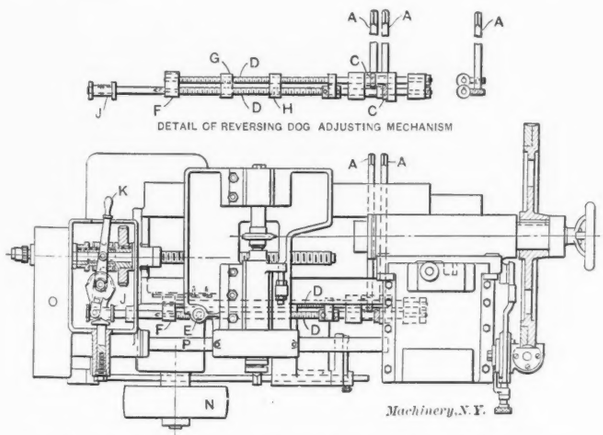


Fig. 4. Plan of Gear-cutter, with Detail of Stop Adjusting Mechanism.

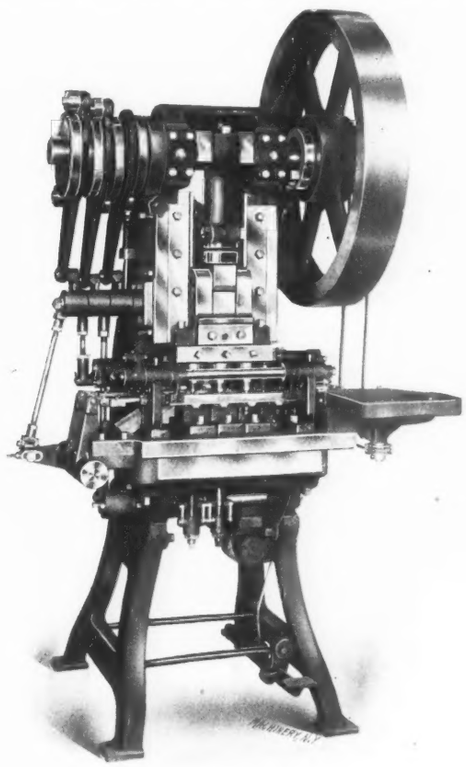
the feeding movement. Then, as is easily seen from the above description, the cutter slide will reverse at these positions. The crank for operating the cutter slide feed-screw is permanently mounted in place, but disconnects itself automatically when not being manually operated, so that it does not give trouble from its balance wheel effect as it rapidly revolves, or from catching in the clothing of the operator.

The indexing mechanism is effective, yet free from trappy, complicated parts. It operates without shock and is easily accessible. As has been mentioned, it is so interlocked with the feed-screw that the cutter cannot enter the work until the indexing has been completed. The number of gears in the indexing train has been reduced by the novel means provided for disengaging the index worm from the wheel. This is shown in Fig. 3. The vertical index worm-shaft is driven by bevel gearing in box *L*, which may be swung about axis *X X*. In throwing the worm out of connection with the index worm-wheel, the worm-shaft is simply rocked about its axis, suitable provision being made in the mounting of the worm for guiding it and bringing it back to its proper relation with the wheel. The index wheel is made in two parts, by the method commonly followed in such cases to insure the required degree of accuracy. The work spindle may be made to space once or to revolve continuously, by the operation of the indexing lever shown near the gear casing at the left of Fig. 2. Index gears are furnished to cut all numbers of teeth from 12 to 100 and, with the exception of prime numbers and their multiples, from 100 to 450. Special gears for cutting other numbers of teeth are furnished at an additional cost, if desired.

This machine is at present made in two sizes for cutting gears of 36 and 48 inches diameter, respectively, up to 10 inches width of face. It will cut 3 diametral pitch in cast iron, and 4 diametral pitch in steel. An outer support is provided for the work arbor, as well as a roller support for the rim of the gear blank. The net weight of the machine and counter-shaft is 4,000 pounds. The machine may be very easily arranged for motor drive, a constant-speed motor being secured to an extension of the base, and connected with the constant-speed driving shaft by spur or chain gearing.

BLISS AUTOMATIC GANG PRESS.

The E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y., has recently built the automatic gang press we herewith illustrate and describe. It was designed and built for performing at each stroke, simultaneously, the second, third and fourth operations on shells on which the first operation of cutting



Bliss Press for Performing entirely automatically Three Successive Operations on Drawn Blanks.

and forming has previously been done in another press. The feeding of the work to the machine, and the transfer from the second to the third and fourth operations, are effected automatically, it not being necessary at any time for the operator to have his hands near the dies, thus doing away with all possible danger from accident.

The drawn shells on which the die operations are to be performed, are laid on a revolving friction dial which forms the bottom of the hopper or tray at the right of the machine.

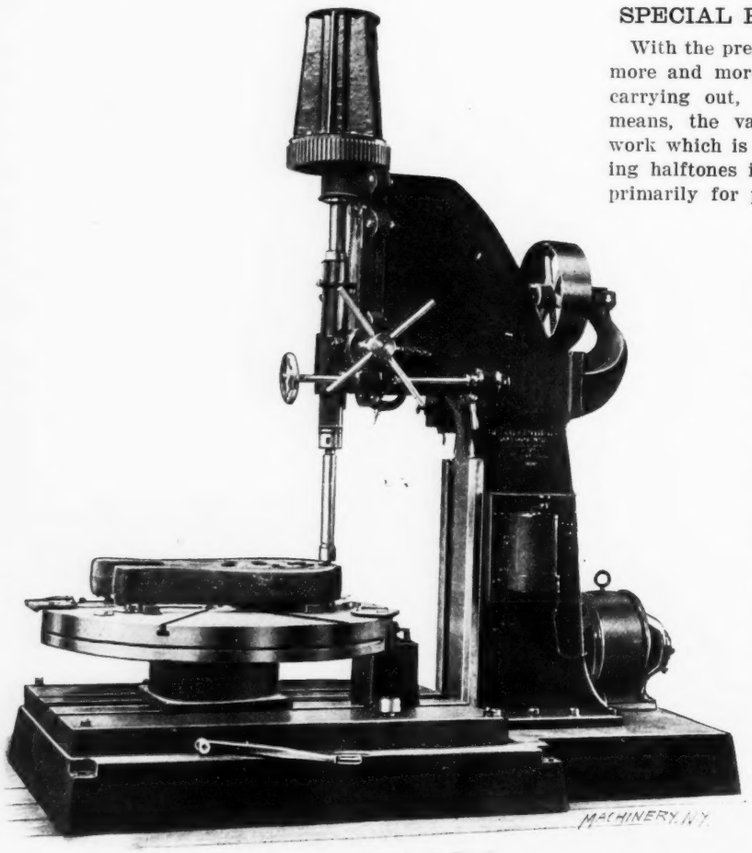


Fig. 1. Baker Bros. Reaming and Tapping Machine for Hot Water Heater Sections.

This disk, which is driven by a round belt from a groove cut in the hub of the fly-wheel, carries the shells up to a stop, from which they are automatically released one at a time, and gripped by a reciprocating lateral feeding movement, operated by the bell crank lever seen at the extreme left of the bed of the machine. This movement carries the shell from the feeding position through the subsequent operations, finally discharging it into a chute, from which it falls into a receptacle conveniently placed to receive the finished article. After the first three revolutions of the press, a finished blank is produced at each revolution.

Of the three cam movements at the left end of the crank-shaft, the first one operates the reciprocating movement for the feed, through the bell crank levers just mentioned; the second one opens and closes the reciprocating guides for feeding the work forward; and the third one operates a positive knock-out motion, seen beneath the bed of the machine.

The main slide is adjustable, allowing the use of dies for a great variety of articles, and provided for different heights of dies, as well as allowing for the wear to which they are subjected. The lateral feed is also adjustable for different kinds of work. As may be seen, the press is of the inclinable type, adjusted by a worm and worm segment beneath the bed. For the work being performed in the case shown, however, the vertical position is the most suitable one.

The press runs at the rate of from 75 to 100 strokes per minute, the rate depending on the size and shape of the shell on which the operations are to be done. From 225 to 300 operations per minute are thus performed, entirely eliminating the intermediate handling between the operations, saving much time, labor and shop room.

SPECIAL REAMING AND TAPPING MACHINE.

With the present specialization in manufacturing, it becomes more and more desirable to have special machines built for carrying out, in the shortest time and with the simplest means, the various operations required on interchangeable work which is produced in large quantities. The accompanying halftones illustrate a special machine which is designed primarily for performing a few reaming and tapping operations on sections used for hot water heaters. Such a section is shown most plainly on the table of the machine in Fig. 2. These sections have, in the first place, three holes, one at the extreme top, and one each at the lower ends of the two legs, which must be bored and reamed to a nice fit. In these holes taper bushings, tapering both ways so that one end enters one section, and the other, the next, are inserted. These bushings then form the joint between two sections. The work is required to be very accurate, so that the sections can be drawn up together closely at the three points forming the joint. In Fig. 1 is shown the machine when carrying out this operation, together with the work placed on the machine table, the hole previously referred to at the top of the section being reamed. The sections are clamped on a circular revolving table as shown, and are located by a stud in the center of the table, which enters the center hole. The three holes to be bored and reamed are placed equidistant from the center, so that all that is necessary after the work has been properly located on the revolving table, and placed in proper position in relation to the machine spindle, is to revolve the table to

Fig. 2. Machine with Revolving Table Removed, and Work Mounted on Lower Rectangular Bed.

the successive positions. It will be noticed that an indexing arrangement is provided, with slots in the side of the revolving table, so that when rotating the table and indexing, the holes will be located exactly alike on the different sections. The table is mounted on ball bearings so that it can very easily be swung around from one position to the other. As soon as all three holes are bored, the boring-bar is removed, and the holes taper reamed. The reaming operations are first performed on one side of a great number of sections, and then taper bushings, which are to fit the reamed taper

Fig. 3. View of Reaming and Tapping Machine, showing Pit in Base permitting High Work to be operated on.

holes, are placed in position in the table, and the sections are turned over so that the taper hole which is reamed fits over the bushing, and then the taper holes on the other side of the section are reamed. This method insures exact alignment of the reamed taper holes on each side of the section.

In addition to the operations on these sections shown in Fig. 1, there are other holes in the top and the legs of the sections which require tapping. The tapping of the hole in one of the legs is shown in Fig. 2, and the tapping of the hole in the top of the section is shown in Fig. 3. The last of these photographs shows only the work in position, without showing the jigs for holding it. It will be noticed that in Fig. 3 a novel feature of the construction of these special machines is shown. The base of the machine contains a large pit 40 x 56 inches, which permits high work to be operated upon. This opening is covered with the rectangular table shown in Fig. 2, on which, finally, the circular table shown in Fig. 1 is placed, when it is in use.

Referring to Fig. 2, it will be noticed that this machine is provided with individual motor drive, and that the speed changes are accomplished through the gear box shown on the side of the machine. The machine is built in two sizes, the one shown in Figs. 1, 2, and 3 respresenting the smaller size. In Fig. 4 is shown the larger size which here is shown belt driven; but either of these sizes may be belt or motor driven. The belt-driven machine shown is of exceptionally heavy design, and has a capacity for tapping holes up to 10 inches pipe tap size. As will be seen from the engraving, this machine is provided with triple back gearing and four different belt speeds, giving a large variation of spindle speeds.

A special feature of all the tapping machines built by Baker Brothers, Toledo, Ohio, who are the manufacturers of these machines, is the spindle drive, the design of which is shown in all the accompanying halftones. Instead of driving the spindle by means of a simple key and keyway, the motion is transmitted by means of a strongly designed driving head at the upper end of the spindle. This permits far greater power to be safely transmitted to the sliding spindle than is possible by commonly used driving arrangements.

SLOAN & CHACE PRECISION BENCH MILLING MACHINE.

The bench milling machine shown herewith is built by the Sloan & Chace Mfg. Co., Ltd., Newark, N. J. It is intended especially for tool-room use and experimental work, although it is adapted to some classes of precision manufacturing. It is built along the lines of the full-sized standard milling machine, with such alterations in design as to fit it for the more minute and accurate work it has to do.

One provision incorporated in the machine, which may be employed where extreme accuracy is required, is that for holding the head-stock of a bench lathe on the table of the miller. It is possible, owing to this provision, after setting up a piece of work on the face-plate or chuck of the lathe, and

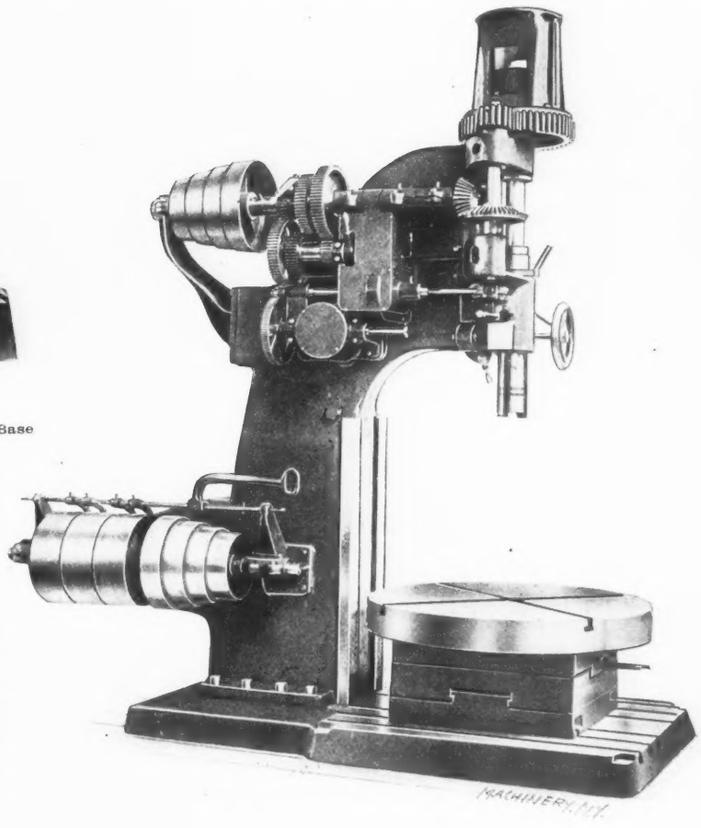
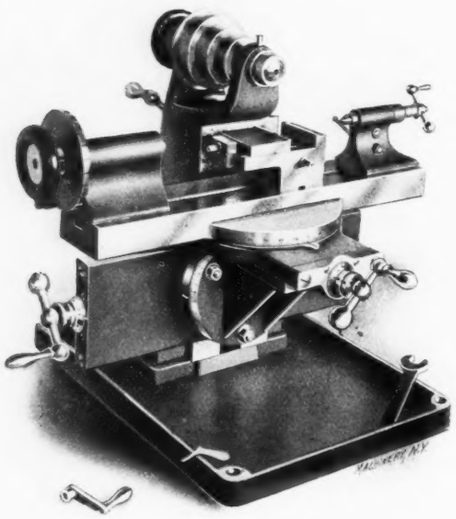


Fig. 4. Large Size, Belt-driven, Reaming and Tapping Machine.

performing the turning operations, to remove the head-stock of the lathe to the milling machine table, and clamp it there in place of the regular index head provided with the machine, using an adapter furnished for the purpose. Another respect in which it differs from the larger machine is in the arrangement of the slides. Instead of having the table longitudinally adjustable on the saddle, the knee is attached to a slide which is longitudinally adjustable on a saddle, which is in turn vertically adjustable on the face of the column. This change of construction is made to allow the most convenient use of an extra angular adjustment provided, by means of which

the work table may be set in any desired angular position about a horizontal axis parallel with the spindle. This angular adjustment, which is made by swiveling the knee on the longitudinal slide to which it is attached, largely increases the usefulness of the machine. In combination with the table swivel and the index head, it permits angular settings in three planes.

The index head carries a hardened and ground spindle of the same diameter and chuck capacity as the cutter spindle,



Sloan & Chace Bench Milling Machine for Precision Work.

which is, in turn, similar in the same respects to the spindle of the maker's regular No. 5½ lathe. The tail-stock is accurately fitted to the table, and is bored in special fixtures which insure accurate alignment. The table has a working surface 22 inches long, allowing a maximum of 11½ inches between the index head and tail-stock centers. When the head and tail-stock of the No. 5½ lathe are mounted on the table, there is a distance of 6½ inches between centers. The feed-screws of both cross and longitudinal slides have adjustable dials, graduated to read to thousandths of an inch, and provided with adjustments for taking up wear. The elevating screw is operated by a bevel gear shaft having a hand crank at the back of the column, and is capable of easy and accurate adjustment by means of adjustable graduations.

The vise provided has jaws 3½ inches long by ¾ inch deep, and will open to take in 2⅛ inches. It may be used in either a horizontal or a vertical position. The vertical travel of the machine is 7 inches, the longitudinal movement is 10 inches, and the transverse movement is 4¾ inches. The counter-shaft provided has two speeds. The net weight, including the counter-shaft, is 308 pounds.

CLEVELAND DOUBLE TANG DRILL SOCKET.

We show herewith a new drill socket made by the Cleveland Twist Drill Co., Cleveland, O., embodying a special feature calculated to overcome the troubles incident to the driving of taper shank drills of the usual construction. As may be seen, a double tang is provided—one of the usual size, and

A Drill Socket with Double Driving Tangs.

an additional one of greater thickness. If the smaller one should break off, there is still the larger and stronger one to hold and drive the drill.

Not only does this device hold taper shank tools so that tangs cannot be twisted off, but old tools with tangs broken off can be ground or milled with new tangs to fit these sockets, so as to renew their life to the full extent of their usefulness. Most shops have an accumulation of drills that would still be serviceable except for their broken tangs. No turning down or key-way milling is required to fit these tools for use with this style of socket.

Any taper shank tool can be easily fitted to this line of sockets by grinding or milling a second tang below the original one. This second and stronger tang fits in the secondary opening of the "Perfect" socket, as the makers call this device. The shank is thus held by two bearing surfaces which cannot be twisted off under the severest strains. In contrast with some previous attempts at improved sockets, which have been complicated and high priced, this arrangement is both simple and inexpensive. It has no parts to get out of order or to wear out, and it fits any spindle having a regular taper hole.

STANDARD MACHINERY COMPANY'S LIGHT POWER PRESS.

The small power press shown herewith is being placed on the market by the Standard Machinery Co., 7 Beverly St., Providence, R. I. It is designed especially for light optical, hardware and jewelers' work, but is well adapted for all light operations requiring press work of any kind.

One of the features of the press is the clutch used. This is the Horton patented roller friction clutch, which engages instantly, there being less than 1/32 inch travel of the periphery of the fly-wheel from the time the treadle is pressed until the clutch takes hold. This clutch is of exceptional

A Power Press for Optical, Jewelers' and other Light Work.

strength, as well as being quick in its action, since there are several positive engagement points which connect simultaneously, giving a very rigid connection between the fly-wheel and the crank-shaft. A positive safety stop is provided which prevents the possibility of a second stopping in case the treadle is released and again depressed. When it is desired to run the machine continuously, the stop may be removed from the clutch, this being done by simply sliding it out of position.

All bearings are adjustable for wear, the slide having particularly long bearings with adjustable side gibs providing an accurate and easy means of alignment. The adjustment

of the plunger for vertical position is made by operating an eccentric bushing with a clamping collar, surrounding the crank-pin; this does not affect the length of the stroke. The base of the press is made with an opening of any size ranging from ½ to 4½ inches, and may be provided with a small drawer, shown in the engraving, to catch finished work. The table may be used, or the tool may be used as a bench press. Punches with round shanks or dove-tails may be used; both methods of fastening have been provided for in the design.

The regular stroke of the machine is 1 inch; when desired it may be made as large as 1½ inch. The adjustment for the stroke is ⅜ inch, and the distance from the slide to the bolster with stroke up and adjustment down is 5½ inches. The total weight of the machine with table is 300 pounds. The normal speed of the press is 300 revolutions per minute.

SPRINGFIELD AUTOMATIC RING WHEEL EDGE GRINDER.

The accompanying half-tones show front and rear views of an automatic edge grinding machine, built by the Safety Emery Wheel Co., Columbus Ave., Springfield, Ohio. This machine is intended for grinding from the rough, flat edges and surfaces in iron, steel, brass, bronze, etc. The grinding process for this work not only removes the stock very rapidly, but leaves a fine finish as well—finer than can be obtained by any other means practicable for heavy work.

The machine is very heavily built. The base is in one solid casting of T-form, on the front portion of which is located the table support, while the rear is provided with ways to which is gibbed the heavy column on which the wheel spindle head is carried. The table is reciprocated automatically, suitable stops being provided for limiting its movement, as may be desired. The wheel column is fed automatically toward the work at any rate of feed required.

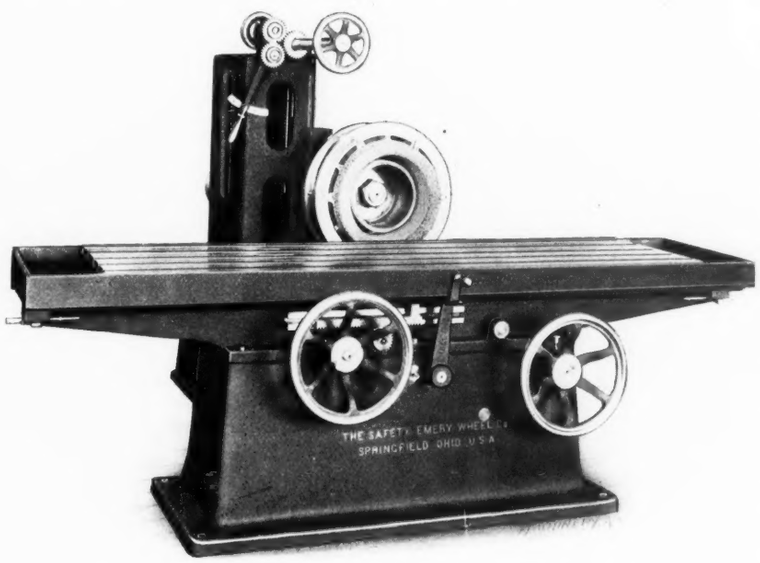


Fig. 1. Front View of Springfield Edge Grinder; note the Safety Chuck for the Ring Emery Wheel.

The spindle is driven from a drum on the counter-shaft by a flying belt arrangement, whose tension is maintained, whatever the vertical adjustment of the spindle may be. The tension is kept to the proper amount by shifting the lower idler pulley, which is attached to a bracket sliding in ways on the rear of the column, being adjusted by the screw shown. The wheel slide has a vertical adjustment of 12 inches on the column, which may be obtained by hand or by power. In the latter case, it is operated by the small pulley at the top of the column, and controlled by the tumbler gearing and hand lever shown. The grinding wheel is of the ring or cylinder shape, firmly held in the patent chuck made by this firm. It permits with perfect safety the high speed which is essential to fast cutting. The wheel spindle is supported in very heavy boxes with suitable thrust bearings to take up end play.

An extra long bed supports the carriage, which travels on one flat and one V-way. The working surface of the table is provided with T-slots for clamping work or jigs and fixtures required for holding it. The carriage movement is triple back-geared, all gears and racks being cut from the solid. The motion of the carriage is easily controlled by the operator, being stopped at any desired point by centering the vertical reverse lever on the front of the bed, when it may be moved by hand, by means of the large hand-wheel at the right in Fig. 1. The reverse dogs which actuate this lever are provided with threaded contact points, which may be adjusted to give at each end of the table motion a greater or less movement to the sliding rack, seen beneath the edge of the table in Fig. 2. This rack operates a pinion, which, through a ratchet movement, operates the cross feed screw by means of which the wheel column is fed forward on the bed toward the work. Any feed, from 0.001 inch to ⅛ inch or more may be given to the column. All the operating mechanism is on the front of the machine, within easy reach of the operator in his working position.

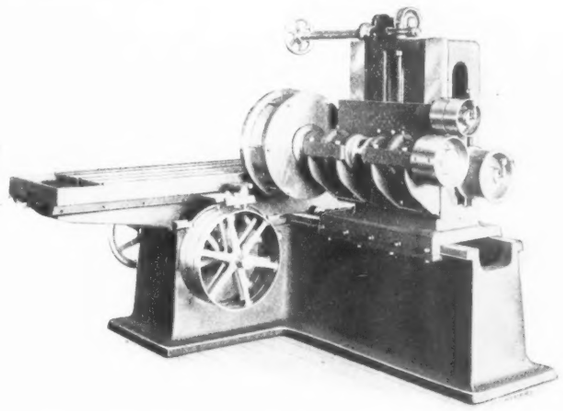


Fig. 2. Rear View of Edge Grinder showing Spindle Drive and Table Reversing Mechanism.

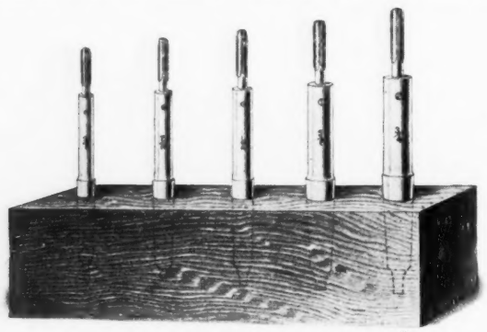
The machine is fitted for supplying water to the grinding wheel when desired, as is necessary for grinding steel. The rearward extension of the base serves as a water reservoir, from which the water is drawn and delivered to the work by a centrifugal pump.

This machine is made with a table working surface 70 inches wide, and of any length up to 130 inches. The machine shown has a working surface 50 inches long. On the larger sizes, a central base is used, with pedestal end supports for the bed. To adapt the work to knife grinding, the builders furnish a heavy knife bar, which can be bolted to the table for grinding any length of work up to the capacity of the machine; this can be readily removed when not needed. For the heaviest grinding of this kind, such as finishing off locomotive guide bars, etc., the builders recommend a heavier form of the machine, carrying a larger wheel, with a solid head.

CINCINNATI PERMANENT TAP SOCKETS.

When drilling and tapping in a drill press or drilling and tapping machine, considerable time is often consumed in changing from the drill to the tap, difficulty often being experienced because a suitable device for holding the taps is not at hand. It also takes considerable time to insert the various taps in, and remove them from, the holders. The Cincinnati Machine Tool Co., Western Avenue and Frank St., Cincinnati, Ohio, which makes a specialty of manufacturing the Cincinnati heavy pattern upright drilling and tapping machines, has therefore placed on the market tap holders of the description shown in the accompanying engraving, which, while very simple, have proved in their own shop a very effective means for overcoming the difficulties mentioned.

Each size tap is provided with a socket, having a shank to fit in the drill press spindle, as indicated. The tap remains permanently in its socket until it is worn out, and is then replaced by another tap. By this arrangement, the changing from the drill to the tap becomes very simple, the tap with its holder being simply slipped into the drill spindle socket, the same as if the tap itself had a taper shank. This entirely



Set of Five Cincinnati Permanent Tap Sockets.

eliminates the loss of time incident to the use of other tap holders. In the illustration, five tap holders are shown placed in a convenient wooden block ready for use. These holders are regularly provided with Morse taper shanks, but holders are also furnished with any other taper shank, or with straight shanks suitable for the "Presto" or "Magic" chucks.

HORIZONTAL MILLING ATTACHMENT FOR VERTICAL MILLER.

The design and construction of the vertical milling machine was immediately followed by the vertical spindle attachment for the horizontal type of machine; the accompanying illustration shows how this, in turn, is followed by the horizontal milling attachment for the vertical machine. The line engraving, Fig. 1, shows the design of a horizontal milling attachment for a vertical milling machine as made by the Becker-Brainard Milling Machine Co., Hyde Park, Mass. In Fig. 2 this attachment is shown applied to the vertical spindle of a Becker-Brainard vertical milling machine, at work on a steam turbine rotor.

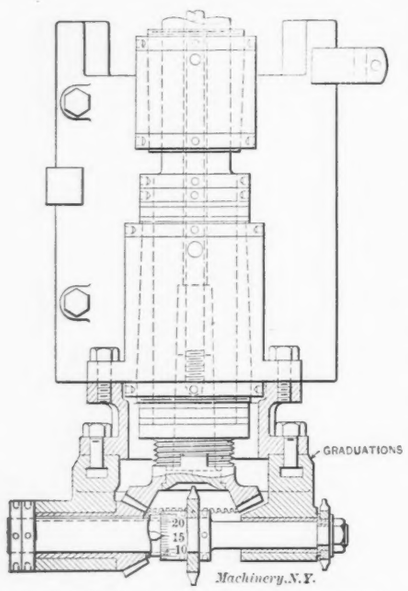


Fig. 1. Design of Becker-Brainard Horizontal Milling Attachment for Vertical Millers.

The attachment as shown in Fig. 1 consists essentially of two parts, the upper one of which is stationary, while the lower one is attached in such a manner that it can be swiveled completely around in a horizontal plane. The stationary part is attached to the column of the milling machine, and the swiveling part is provided with graduations at the place where it joins the stationary part, so that it can be accurately set and adjusted to any angle required, when it is clamped in position by the T-bolts shown. The horizontal spindle which is driven from the vertical spindle through bevel gears arranged as indicated in the line engraving, has a long bearing at each end. The milling cutter may be placed either on the outside end of the horizontal spindle, beyond the right-hand bearing, or between the two bearings. In the latter case, of course, the size of the cutter is limited by the driving bevel gear. The end play of the horizontal spindle is taken up by a nut provided with a check nut placed at the left-hand end of the spindle. At the other end, the cutter is clamped with a nut and washer, but the spindle may also be provided with a taper hole, taking the taper shank of an end milling cutter or shank mill.

The cutter when placed between the two bearings, as indicated, is specifically intended for cutting spirals, although it may also be used for general requirements. This cutter is held between two nuts as shown, one of which is graduated so that if adjustment has once been made for any given thickness of cutter, it being required to hold the cutter exactly in the center of the vertical spindle, any cutter of the same thickness may be set without requiring a new adjustment. It is evident that this attachment materially increases the usefulness of the vertical miller. It gives the vertical miller the same range as the horizontal type in the cutting of worms, spur gears, spirals, hobs, racks, etc., while, at the same time the machine retains the advantageous characteristics peculiar to the vertical type.

As mentioned above, a practical application of the horizontal attachment in connection with the No. 6 Becker-Brainard vertical milling machine, is shown in Fig. 2. It is here employed in milling the buckets of a Sturtevant steam turbine

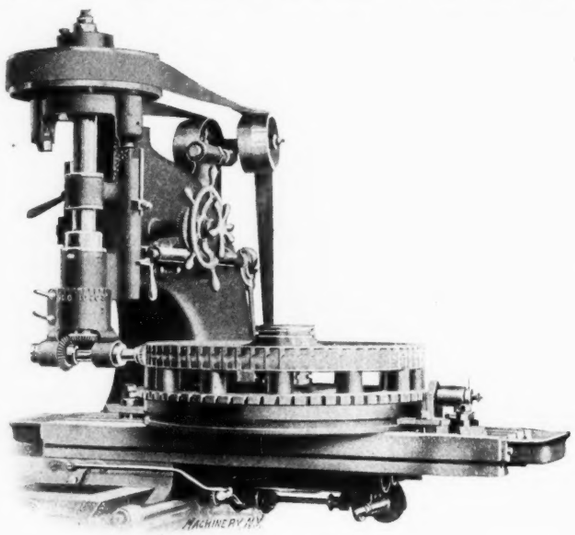


Fig. 2. Horizontal Milling Attachment at Work on Steam Turbine Rotor.

rotor. The rotor is mounted on and clamped to a special index plate, which revolves freely on a stud projecting from a circular face-plate, which, in turn, is securely clamped to the table of the milling machine. An index pin entering the slots in the indexing plate, as plainly indicated in the half-tone, permits the rotor to be indexed around while each bucket is being milled. On account of the limited space between the column and the table in a horizontal milling machine, work of this character would be difficult, if not impossible, to perform on an ordinary horizontal machine, even with the use of a universal milling attachment. On the vertical miller, however, the space is not so limited, owing to the design of the column, and the use of this horizontal attachment in a vertical miller will permit a large variety of work to be performed on the vertical machine, for which either a larger horizontal machine or special machinery would be required.

TOSCOT FLEXIBLE METALLIC BELT COUPLING.

One difficulty common to flat belt couplings is that they form a rigid joint where the two ends are coupled together, so that if a belt provided with such a coupling runs over a small pulley, heavy strains are produced at the extreme edges of the coupling, which cause the belt to break along this line. In Fig. 1 is shown the Toscot flexible coupling, which overcomes this defect. This coupling is manufactured by the Tostevin & Cottie Mfg. Co., 635 Kent Ave., Brooklyn, N. Y.

It is provided with a joint in the center where the ends of the belt meet, and therefore permits the belt to come in close contact with the pulley all the way around.

Another improvement is that the coupling is so designed that it can be easily unhooked whenever it is desired to take

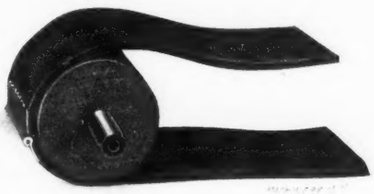


Fig. 1. Toscot Flexible Belt Coupling applied to Small Pulley.

the joint apart or remove the belt. The hooking arrangement is shown plainly in Fig. 2, where the two ends of the belt, each having one section of the coupling attached, are shown as they are being uncoupled. The two sections of the coupling can be attached to the belt ends in any convenient place, and the belt taken to the respective pulleys where it is to be used, laid over the pulleys and simply hooked together. The attaching of the coupling to the belt is accomplished very easily. The end of each section of the coupling, which

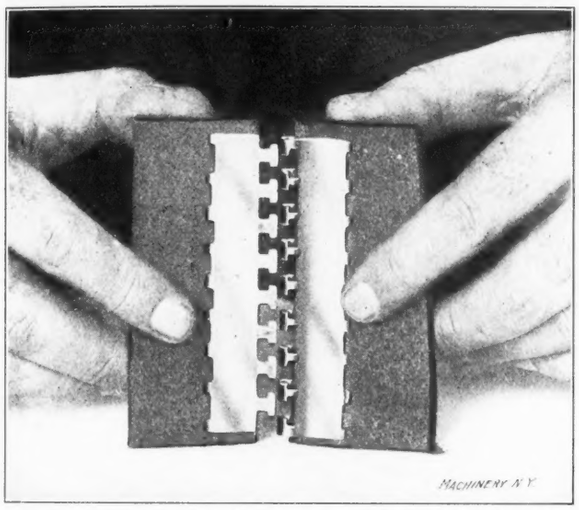


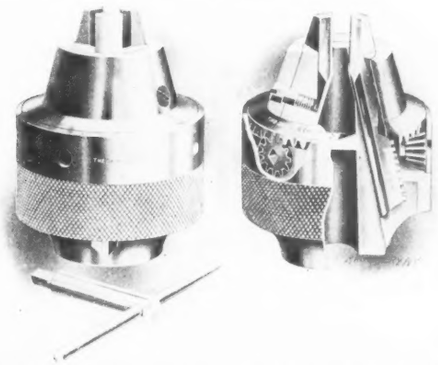
Fig. 2. View of Joint of Coupling showing Simplicity of Unhooking Belt.

is attached to the belt end, is provided with teeth. These teeth are driven through the belt with a hammer, using a backing consisting of a soft wooden block. The belt is then turned over, and the ends of the teeth clinched, the points being driven well into the leather. The convenience and simplicity of this operation is evident. These couplings are made for all standard widths of belts, varying from one inch to six inches.

SKINNER GEARED PATTERN DRILL CHUCK.

The Skinner Chuck Co., 94 N. Stanley St., New Britain, Conn., is making the improved style of drill chuck shown in the accompanying halftone. In the previous chuck of this type made by the same builder, the jaws were tightened by twisting the knurled sleeve by hand. When a strong grip was desired, it was obtained by the use of the spanner wrench. This latter means of tightening the chuck is sometimes objectionable on a light drill press, where the spindle has a tendency to turn with the wrench. In this new geared pattern chuck it is possible to operate it by hand as before, and, in addition, provision is made for using the common form of key wrench, by which the jaws may be tightened sufficiently to drive a high speed twist drill to its limit. In tightening the chuck in this manner, there is no strain tending to revolve the spindle of even the lightest machine.

As may be seen in the engravings, the improvement consists in sinking bevel pinions into the body of the knurled sleeve, and providing these pinions with a stationary gear for them to mesh with, fast to the body of the chuck. These pinions have square sockets, which may be reached by openings in the sleeve as shown, and may be operated with a common square key. As the chuck is tightened by the operation of these pinions and the key, the pinions travel on the gear, giving a very powerful grip. The key, however, is only used for giving the final tightening and for unloosening the chuck. All adjustments for different sizes of tools are effected more quickly by revolving the chuck by hand. Two pinions are provided, thus insuring longer life to the gearing and making it more convenient to apply the wrench. In case one pinion should break, the chuck would still be available for service, with the remaining pinion.



New Pattern of Skinner Chuck which allows Tightening without Revolving the Spindle.

This tool is made with the same care used by the makers in the rest of their line. As in their other chucks of this design, a standard brand of steel is used for the jaws, this same make and brand having been used for years without change. Each jaw is hardened to an exactly uniform heat, this being made possible by the use of an electric furnace. Every chuck is tested for accuracy before leaving the works and the error carefully measured. No inaccuracy of over 0.002 inch is allowed to pass. Attention is called to the long bearing of the jaw in the solid threaded nut, and the angular bearing of the jaws on the bottom of the slot milled in the chuck body. Owing to the way in which these jaws are supported in these milled slots, they have no tendency to turn or rotate from the strain of driving the tool. The gears and pinions are hardened, and the jaws and cap are hardened and ground. The appearance of the chuck is neat, and there are no projections to injure either the work or the workman.

This chuck can be furnished with a hole through the center of the full capacity of the chuck, when it is desired to use it on a hollow spindle machine. It is readily taken apart for cleaning and oiling, a screw driver being the only tool necessary. Two sizes are now ready for delivery and other sizes will be furnished later.

BARNES 20-INCH UPRIGHT DRILL.

A medium-sized drill press of an entirely original design has been placed on the market by the Barnes Drill Co., Rockford, Ill. The novelty of the design and arrangement of the component parts is at once apparent upon examination of the accompanying halftone. The drill press, as shown, is provided with geared drive, located in the gear box at the lower end of the part of the frame where the driving and feed mechanism is placed. The main shaft in this gear box is driven from the horizontal pulley shaft by means of bevel gearing. There are four changes of speed in this gear box, without resorting to the back gears, and these speeds can be easily and quickly obtained without stopping the machine, by operating one of the two shifting levers shown on the front side of the gear box. The back gears, contained in a cover or box by themselves, are placed diagonally above the gear box, and operated by the lever shown. By means of the back gears operated in connection with the gear box, eight changes of speed can thus be obtained, which is sufficient for all twist drills from ¼ to 1½ inch in diameter. The ratio of the back gears is 4 to 1.

Diagonally above the back gear box is placed the mechanism for the positive power feed. Any feed from 0.001 up to 0.025 inch can be instantly obtained while the drill is in motion by shifting the small index lever shown directly in front of the drill spindle between its two bearings. The feed changing mechanism is of an entirely new design, and its practicability and convenience add much to the utility of the drill. An automatic stop for the feed is also provided. The hand feed is operated through the spider or star wheel having three handles, located as shown in the half-tone. On the shaft on which this spider is placed a pinion is provided which runs with an internal gear, which in turn is connected with the pinion engaging with the feed rack. By this arrangement the leverage of the handles on the spider is equivalent to levers of hand-feed mechanism of the common design four times as long. The spider or star wheel also acts as a quick return lever.

Barnes 20-inch Upright Drill Press with Geared Drive of Original Design.

The remaining details of the machine are plainly shown in the halftone. The round table is regularly furnished, but square tables are also supplied on request. The table is raised and lowered by operating a crank connected by bevel gears with a screw located as shown. The bracket holding the table may be swung in an arc of nearly 180 degrees around the post.

If this machine is required to be fitted out as a tapping machine, reversing friction pulleys are put in place of the tight and loose pulleys shown in the half-tone, and this arrangement permits the machine to be used for tapping purposes as conveniently as machines with expensive geared tapping attachments. The engraving shows the machine driven from the counter-shaft, but these drills are also fitted with electric motors and starting rheostat, which makes the machine completely self-contained.

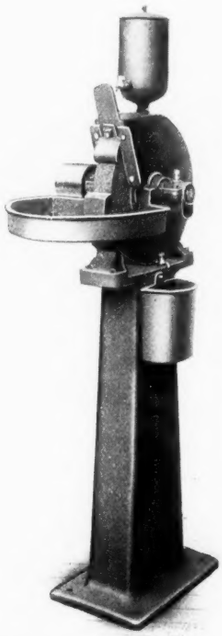
The frame of the machine, as can be easily perceived from the illustration, is of a rigid design; the column is heavy for this size of drill, and the back brace for supporting the gear boxes and feed mechanism makes it very rigid. This will be understood when it is known that the tool will drive a one-inch high speed twist drill, running at 190 revolutions continuously, at a feed of 2 inches per minute in steel, and 3 inches per minute in cast iron, without engaging the back gears. All levers and handles are easily within the reach of the operator when standing in front of the drill.

The height of the drill is 70 inches, the distance from the column to the center of the table is 10¼ inches, the maximum distance from the spindle to the table is 26¾ inches, and from the spindle to the base, 42 inches. The vertical travel of the spindle is 10 inches, and of the table 16 inches. The spindle is bored to take a No. 3 Morse taper. The floor space required, exclusive of the tight and loose pulleys, which overhang 7 inches, is 37½ x 16 inches, and the complete drill, back-geared, with positive power feed, weighs 740 pounds. The machine will, however, if required, be furnished without back gears, and also without a power feed and automatic stop, having simply the plain star-wheel feed lever for hand feed only. It should be noted that this machine is made by the Barnes Drill Co., and not by another firm of similar name.

EDGEMONT WET TOOL GRINDER.

The Edgemont Machine Co., Dayton, Ohio, is building the wet tool grinder herewith shown. This tool is intended to take the place of the cheap dry grinders so extensively used for tool sharpening. It costs very little, and offers a number of advantages. The danger of burning tools is avoided, and the wheel does not have to run as fast as in the dry grinder.

In comparison with the more elaborate wet grinders on the market, this machine is exceedingly simple and inexpensive. Water is supplied by a small tank on the top, and is allowed to run on the wheel until a sufficient quantity has accumulated on the lower wheel case. Owing to the special design of the casing the wheel is caused by the latter to pick the water up and spray it continuously over the work. There is no pump to get out of order, and no mechanism of any kind to deteriorate from grit and rust.



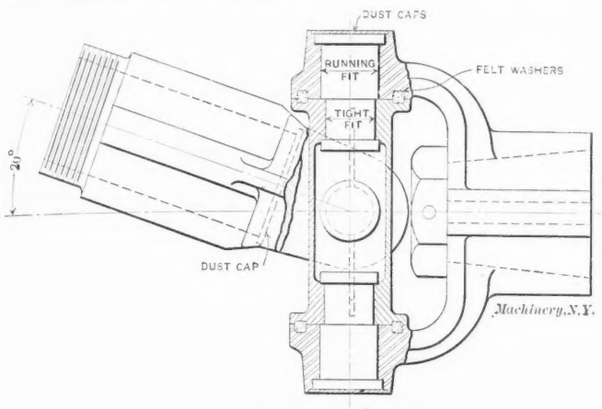
Wet Tool Grinder built by the Edgemont Machine Co.

The machine is well built, with a large spindle of special steel, running in ample journals and self-oiling bearings. The height of the machine from the floor to the spindle is 40 inches. The floor space occupied is 14 x 23 inches. The weight complete is 200 pounds. A corundum wheel 12 inches in diameter and 2 inches face is used, and it should be speeded from 1,200 to 1,500 revolutions per minute. As may be surmised from the engraving, the grinder may be used as a bench machine when desired, the column being separate from the head, so that it may be used or not as convenience dictates.

MUTUAL MACHINE CO.'S UNIVERSAL JOINT.

The growth of the automobile industry has brought forth a great many designs of universal joints; in the accompanying line engraving we illustrate one of these, the Warren patent universal joint, manufactured by the Mutual Machine Co., 25 Wells St., Hartford, Conn. This device is known as the 1909 Universal Joint. One of its important features is the fact that the parts are joined together with rivets, instead of with bolts, as there is no reason to ever take the joint apart after it has once been put in place. To make the mechanism dust-proof, felt dust washers are compressed and placed in cavities in the fork before assembling; after the oil and grease come in contact with the felt, it expands and fills the corresponding cavities in the center blocks, the arrangement thereby becoming dust-proof. The hollow space in the center

blocks is filled, when assembled, with non-fluid grease, which is sufficient to last for several months, and when it is necessary to fill the receptacle again, a small screw, not shown in the illustration, is loosened, and the hollow space supplied with fresh grease. A strong point in favor of this joint is

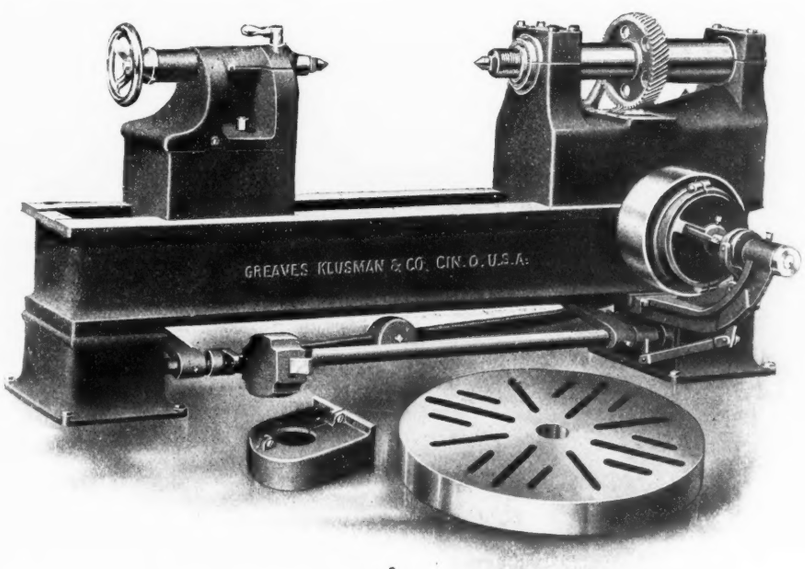


Warren's Patent Universal Joint.

that it is free from bolts, screws, nuts, cotter pins, etc., which are liable to work loose, and that it is unnecessary to apply any protective dust covers. An examination of the design, as shown in the engraving, will give a clear idea of the simplicity and rigidity of the construction.

ARMATURE BANDING AND FIELD COIL WINDING LATHE.

The engraving shows a special lathe built by Greaves, Klusman & Co., Cook & Alfred Sts., Cincinnati, Ohio. This machine is expressly designed to meet the requirements of electric motor and dynamo manufacturers and electrical repair shops, for the banding or armatures and the winding of field coils. For this purpose, the spindle is very strongly driven through the spiral gearing shown, which runs in a bath of oil. The gear casing has been removed in the engraving to show the construction. The change gears provided are attached to the front of the lathe (the engraving shows the rear view) and give four different spindle speeds of 15, 30, 60, and 120 revolutions per minute, respectively. The lower driving shaft passes through the bed and is equipped at the rear end with a self-releasing friction clutch pulley, 14 inches in diameter and 5 inches face, which should run at 360 revolutions per minute. This clutch is operated by a foot pedal



A Special Lathe for Winding Operations in Electrical Work.

running the entire length of the bed, so that the operator can conveniently stop and start the machine from any point. This permits belting the machine direct from the line shaft without the use of a counter-shaft. When a motor drive is desired, a spur gear is substituted for the driving pulley, meshing with a pinion on the motor shaft, the motor being mounted on a bracket attached to the lathe bed.

The machine has a height of 36 inches from the floor to the center line of the spindle, being somewhat lower than the usual dimension, thus making it convenient for the operator when handling heavy armatures of large diameter. The equipment consists of the parts shown in the engraving, including the large face-plate. A counter-shaft is not furnished or required. A 12-foot bed is usually furnished. This will take 8 feet between centers. Longer or shorter beds are furnished if desired. With a 12-foot bed the machine weighs about 3,300 pounds. A special long travel slide rest for turning commutators can also be furnished with this machine if desired.

DAYTON POWER HAMMER.

The accompanying half-tone illustrates a power hammer, manufactured by the Foglesong Machine Co., Dayton, Ohio, and known as the Dayton spring-cushioned helve hammer. The machine is intended to meet the demand for a first-

Power Hammer with Friction Clutch Drive.

class, moderate-priced machine, adapted for the requirements of general manufacture, blacksmith shops, wagon and carriage makers, etc. This machine has been in use in the factory of the makers, subjected to all kinds of work, and under all kinds of conditions, for a long time, and although embodying some interesting features in its design, it is by no means experimental. One of the features of this machine is a friction clutch instead of the common belt tightener for starting and stopping the machine, and controlling the stroke. Another feature of importance, not possessed by the upright style of hammer, is that of permitting such work as welding of circular pieces, tires, etc., to be done very conveniently, as there are no parts in the construction of the hammer which will obstruct the placing of work of any shape on the anvil. This feature will be greatly appreciated by blacksmiths. The driving shaft and the helve are made of hammered spindle steel. The helve is made a tapered fit, and keyed into the head, which is placed between strong and durable steel springs. Provisions are made so that all necessary adjustments can be made instantly, and the foot treadle is arranged so that

the operator can stand in the front or on either side of the hammer when operating it, the variation of the foot pressure on the treadle regulating both the rapidity and the force of the blow.

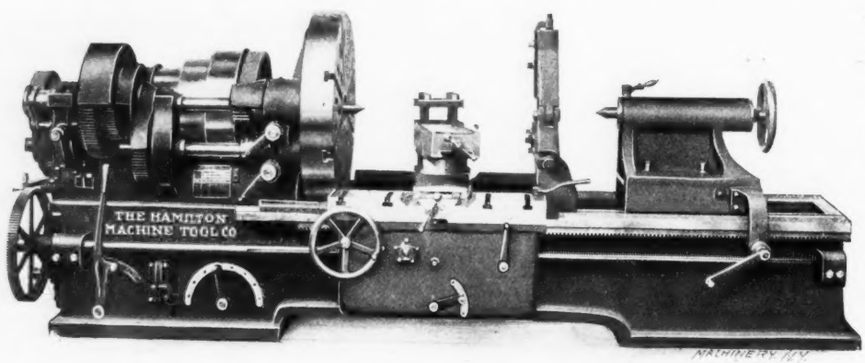
This hammer is made in two sizes, No. 2 and No. 3. The No. 2 hammer weighs 900 pounds, and occupies a floor space of 48 x 20 inches. The distance from the base to the top of the anvil is 24 inches, the length of the helve is 26¼ inches, and its diameter at the large end 2 inches. The length of the stroke is 8 inches. The speed of the driving pulley is 300 revolutions, its diameter being 12 inches; the width of the belt is 2½ inches, and the power required for driving is from ½ to ¾ H.P. On this hammer the manufacturers themselves have welded 1¾-inch steel axles and ¾ x 3-inch tires. The No. 3 hammer is larger and weighs 1,500 pounds, occupying a floor space of 50 x 20 inches. The distance from the base to the top of the anvil is 28 inches, the length of the helve is 34 inches, the diameter being 3 inches. The length of the stroke is 8 inches. The speed of the driving pulley is 250 revolutions per minute, its diameter being 18 inches; the width of the belt is 4 inches, and the power required from ¾ to 1 H.P.

HAMILTON 42-INCH HEAVY LATHE.

The Hamilton Machine Tool Co., of Hamilton, Ohio, has brought out a new 42-inch lathe of rigid construction, known as the Hamilton 42-inch heavy pattern lathe. This machine is shown in the accompanying half-tone, and, as will be readily seen, is of an exceptionally powerful design. It is intended particularly for heavy work, and embodies all the modern features common to the Hamilton lathes, such as quick-change gear mechanism, hollow steel spindle, automatic feed stop, and double apron. The machine may also be equipped with taper attachment, but this is not regularly furnished.

As shown in the illustration, the spindle is driven from the counter-shaft by a 6-inch belt. The cone pulley is provided with three steps, 16, 20, and 24 inches in diameter, respectively, and the speed variations thus obtainable, in combination with the quadruple gearing in the head-stock, allow ample speed changes as well as ample power for the heaviest work to which this lathe would be put. A feature of considerable importance is that the bed is considerably wider than customary, so that when turning work of the largest diameter within the capacity of the machine, the cutting tool is still supported by the outer V in the front of bed.

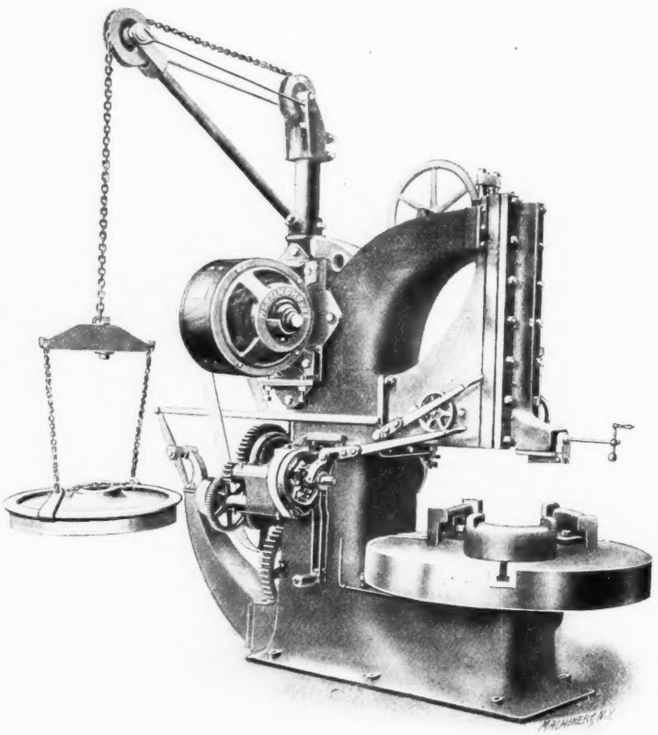
The principal dimensions are as follows: Swing over shears, 42½ inches; swing over carriage, 30 inches; swing over compound rest, 28 inches; length between centers on 12-foot bed, 4 feet 6 inches; range of screw pitches which can be cut, 5/16 to 16 threads per inch. The range of feed is from 2 to 85 turns of the spindle per one inch forward motion of the carriage; the pitch of the lead-screw is one double thread per inch. The face-plate, which is internally geared, is 42 inches in diameter. The speed of the counter-shaft is 160 and 185 R. P. M., the size of the counter-shaft pulleys being 24 x 7 inches. The net weight of this machine, with a 12-foot bed is 24,000 pounds, and the increase in weight for each additional foot in the length of the bed is 450 pounds.



Hamilton 42-inch Lathe of Exceptionally Heavy Design.

IMPROVED MOTOR-DRIVEN CAR-WHEEL BORING MILL.

The accompanying half-tone illustrates a motor-driven car wheel boring mill manufactured by William Sellers & Co., Inc., Philadelphia, Pa., which embodies a number of improvements in car wheel boring mill machinery. The noteworthy features of this machine are the improved automatic chuck, the friction feed mechanism, and the crane attachment. The machine is known as a 54-inch wheel boring mill, and is of particularly heavy construction, and provided with powerful gearing, rendering it capable of taking the heaviest cuts required for the class of work for which it is intended.



Sellers' Motor-driven Car-wheel Boring Mill with Automatic Chuck and Crane Attachment.

The improved automatic chuck is self-closing, self-opening, and self-centering. It has three adjustable abutments, as shown in the half-tone, each of which is provided with an equalizing steel jaw, having two bearing points, so that the work is held and centered by six points on the circumference, thereby insuring accuracy in centering. This automatic chuck enables the work to be secured in its correct position in the machine, and subsequently released without any loss of time and labor. The power of the clutch grip increases with the resistance of the cut, and this feature is very important, as it obviates the necessity of stopping the table in order to tighten the chuck. The general action of this chuck is as follows: The first movement of the driving shaft causes the jaws to close in around the work, after which the motion is transmitted to the table to produce rotation. When the work is completed, the chuck is released by disengaging the driving clutch, and retarding the driving shaft

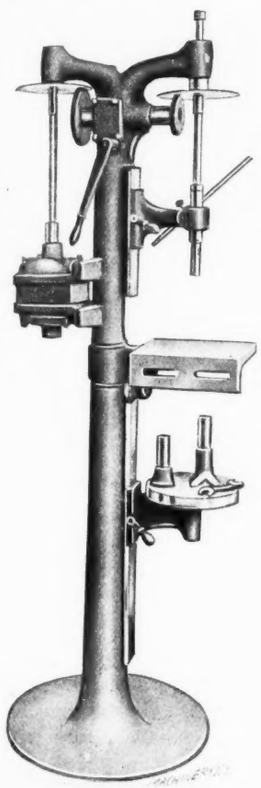
by means of a friction brake, provided for the purpose. The inertia of the table and work will then impart the necessary force required for opening the jaws.

The machine is motor driven, the motor being mounted, as shown in the half-tone, on the side of the machine frame. The motor is a Westinghouse type "S," of 7½ horse-power, capable of a variation in speed of approximately two to one, thereby eliminating all cone pulleys for speed variation. The efficiency of the machine is also increased by this motor drive, because the variable speed motor gives the required speed range in smaller steps, permitting the mill at all times to be run at its maximum capacity.

On the top of the rear part of the housing a crane is fitted, as shown, for lifting the car wheels into place on the table of the machine. This makes the machine very handy to operate, and self-contained in all its features.

MOTOR-DRIVEN VARIABLE SPEED SENSITIVE DRILL PRESS.

Last month we illustrated and described the principal features of a friction-driven sensitive drill press, built by the Washburn Shops of the Worcester Polytechnic Institute. The machine then described was of the belt-driven type. The accompanying half-tone shows the same machine with somewhat different arrangements in its driving parts, designed for motor drive. The arrangement of the motor and the driving mechanism, present novelties which make this modification of the machine very interesting from a mechanical point of view.



Washburn Motor-driven Sensitive Drill Press.

The machine, arranged as shown, has proved a great success, and it is stated that a noticeable feature to everyone who has operated this machine is the smoothness with which the drill is fed into the work, this being due to the entire elimination of belts. The induction motor (which, by the way, is furnished with the machine for either 110 or 220 volts, 2 or 3 phase, 25, 40 or 60 cycles) is bolted to the rear of the column, high enough to clear the square table of the machine when this is swung aside to enable the use of the round table. It also permits chips to be brushed from the table, without the liability of damage to the motor. At the same time, a motor placed in this position presents a neat appearance, and serves in a way to balance the machine against the weight of the square and round table on the other side of the column.

The motor is of constant speed, the speed variations being provided by mechanical means through the friction disks. The details of the friction drive were described in the April issue of MACHINERY, and it will only be necessary to mention the driving arrangement in a general way. The motor runs at 1,200 revolutions per minute, and by means of a double friction disk arrangement, shown at the top of the machine, a speed variation of the spindle ranging from 400 to 1,600 revolutions per minute is obtained. The drill spindle can be stopped without stopping the motor by throwing the speed lever to its extreme position. When in this position, the driver disk is released from contact with the friction roll, the disk being recessed in order to accomplish this. When the friction roll is in contact with the driving disk, its shaft or spindle is raised slightly and the weight of the rotor is taken by the disk, but when in the released position, the weight of the rotor is carried by a special collar. On starting the motor, the friction roll should not be in contact with the driver disk, the motor starting without load; then the friction roll is thrown into contact with the disk. Very little power is required for driving the machine, as the normal pressure on the roll is very slight until the drill is in use, when the pressure increases or decreases with the working pressure on the tool. The machine has some very commendable features, and will, undoubtedly, prove a very efficient sensitive drill.

CENTER GRINDER AND FRAME FOR PORTABLE DRILL.

In Fig. 1 of the accompanying half-tones is illustrated a new type of electrically-driven center grinder made by The United States Electrical Tool Co., of Cincinnati, O. This

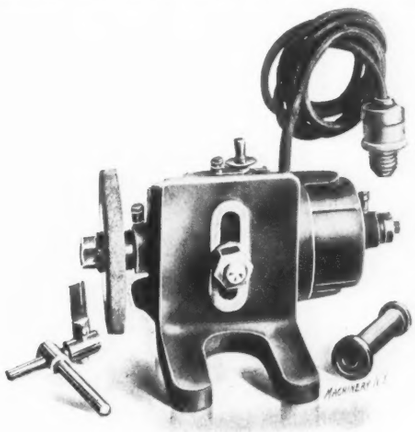


Fig. 1. Electric Center Grinder.

grinder is mounted on an angle plate, as shown. The lower part of the angle plate has a slot provided which straddles the tool-post of the lathe, and the device is clamped to the

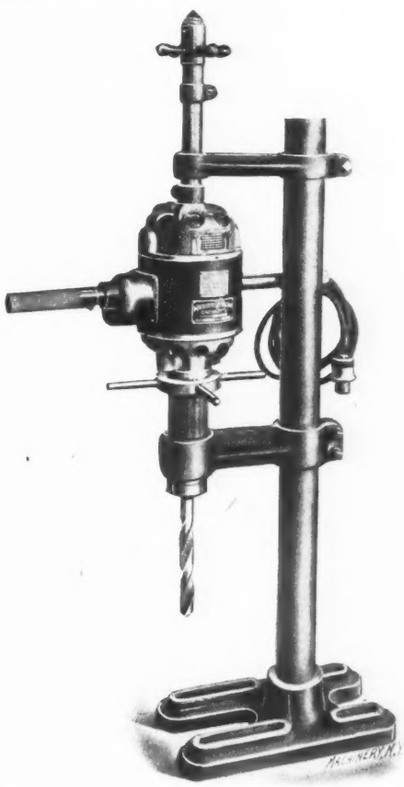


Fig. 2. Improvement of the "Old Man" applied to the Electrically-driven Drill.

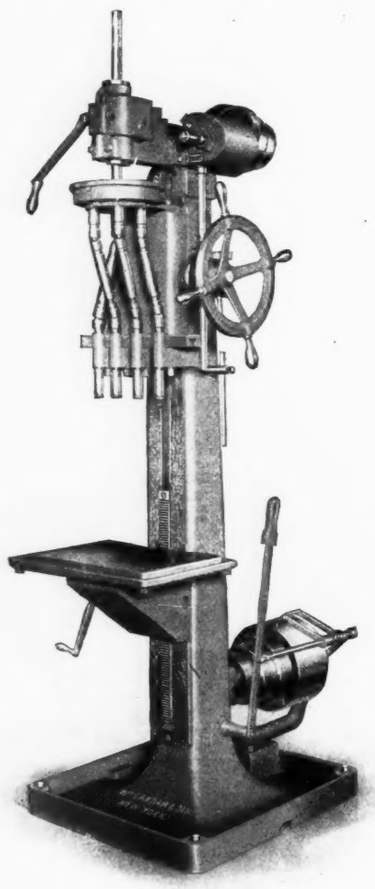
tool-post slide by means of the tool in the tool-post. In this way the grinding wheel with its motor may be held very rigidly, and there is no vibration in the motor of the kind

so objectionable when the motor is attached to a shank. The motor and grinder can be raised or lowered to suit the height of the centers of the lathe by means of oblong slots provided in the vertical part of the angle plate, as plainly shown in the half-tone. The device can also be swiveled to any angle. The bearings are adjustable for taking up the wear, and provided with caps, making them dust-proof. The motor is of the air-cooled type.

Another handy device brought out by the same company is an improvement on the "old man" or a frame for portable drill, as shown in Fig. 2. This device consists of a rigid post, provided with two brackets, one having a plain bearing and the other arranged for feeding the drill. This post is placed in a base provided with oblong slots for clamping purposes. This improvement on the "old man" as usually constructed, will be appreciated and found very handy around the shop where portable electric drills are employed.

GARDAM ADJUSTABLE MULTIPLE SPINDLE DRILL.

The adjustable multiple spindle drill shown in the accompanying illustration is one of a series recently designed and placed on the market by Wm. Gardam & Son, 45-51 Rose St., New York, and intended to take the place, for manufacturing purposes, of the ordinary multiple spindle drilling machine with fixed spindles. The machine shown in the half-tone is adapted for drilling at one time a number of small holes up to ½ inch diameter, and a special feature of the tool is the ease with which it can be handled and the rapidity with which the changes can be made from one series of holes to another. While this particular drill is designed for four spindles, others are made with a varying number of spindles



Gardam Adjustable Multiple Spindle Drill.

having an adjustment forward and back of 3 inches, and sideways of 15 inches, the minimum distance between any two spindles being ordinarily 1¼ inch. The spindles can also be adjusted vertically to allow the use of drills of different lengths, and all are bored to take a No. 1 Morse taper shank. The head which carries the spindles is counterbalanced by a weight inclosed within the column.

The table is supported on a very rigid box knee, and is adjustable by rack and pinion. It is rectangular in shape, 16 x 12 inches, giving an ample working surface, and is surrounded by an oil groove. The size and shape of the table, however, can be adapted to special needs. In order to provide simple means for taking up the wear, the table and head bearings are scraped and provided with gibs. The base is cast with a rim to form an oil pan, preventing the overflow of oil, chips, etc. These drills are very suitable for working in gangs, and several of them may be mounted on a common base, and arranged to work together in groups. When set up in this way, one attendant can easily take care of and operate several machines. The counter-shaft is attached to the base, and is fitted with tight and loose pulleys, and has self-oiling bearings. The driving gears are made of carbon steel, and the machines can be supplied with or without direct-connected all-gear feed, and with or without tapping attachment. If required, they can also be easily adapted for individual motor drive.

THE HELE-SHAW CLUTCH.

One of the severest, and undoubtedly the most difficult and most delicate of all clutch problems, has been presented to the designer by the development of the automobile, and a

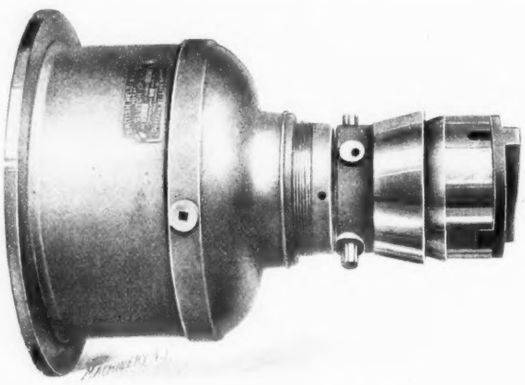


Fig. 1. General Appearance of the Hele-Shaw Clutch.

great many different ideas in clutch design have been due entirely to the development of the motor car. An interesting type of clutch for this as well as for other industrial purposes is shown in the accompanying half-tone, Fig. 1, and the line engraving, Fig. 2. The principal feature is that the power is transmitted through the friction between grooved disks of the cross section shown by the heavy black line at *A* in Fig. 2. A number of these disks are placed in the clutch, the V-groove of each fitting into the V-groove of the next. The power is transmitted by means of the outer edge of one, and the inner edge of the other, of each pair of disks engaging, respectively, with ribs in the outer casing *B* and inner drum *C*, engagement being through special notches cut in the edges of the disks. The outer casing is then attached to the motor or other prime mover, and the inner drum to the driven shaft, or *vice versa*. The spring *D* holds the disks in engagement with each other, until the disengaging lever is moved to the left, pulling with it the part *E* and the sleeve over the shaft *F*, thereby compressing the spring *D*, and releasing the pressure on disks *A*. The action, it is thus seen, is very simple.

It has been found that the V-shaped disks transmit considerably more power and permit a more even "pick-up" than clutches with flat disks. Other advantages claimed are also that the form of the disks permits the bodies of the plates to always be well separated, and leave free access for the oil circulation until the clutch is under engagement. This greatly increases the radiation of heat, as compared with flat disks. The special form also secures greater transverse strength, and the disks do not distort easily. The disks are oiled under ordinary circumstances, but if the oil should be lost by accident, the strength of the disks prevents injury even under the most unfavorable working conditions.

One of the most important features of the Hele-Shaw clutches, however, is their uniform rate of engagement or "pick-up," the engaging qualities being greatly enhanced by the special shape of the groove in the plates. The great number of surfaces and their large area make the clutch flexible and easily manipulated in case of slipping. The load is distributed over all the contact surfaces and therefore but a fraction of the load is placed on each disk, thereby preventing undue wear. When the clutch is first applied, the plates being pressed together by springs, the V-grooves intermesh gradually, bringing the driven series slowly to the speed of those driving, and forcing the oil out between them. The cushion of oil between the plates makes sudden engagement impossible, a factor which is of the greatest importance for motor car purposes. When the oil is finally squeezed out, the plates engage firmly with one another, and all slip ceases. As all lubricated clutches drag minutely the supposedly stationary disks when the car is not running, a small brake is used to stop the spinning of the driven shaft.

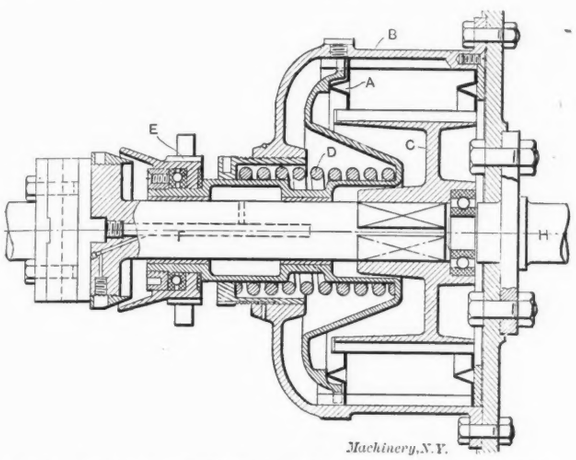


Fig. 2. Section of the Hele-Shaw Clutch, showing Design of Details.

The V-shaped plates are termed "Hele-Shaw friction disks" from their inventor, Professor Hele-Shaw, a description of whose original clutch appeared in the October, 1903, issue of MACHINERY. The clutch is manufactured in the United States by the Merchant & Evans Co., 517 Arch St., Philadelphia, Pa.

HENDEY SINGLE PULLEY AND MOTOR-DRIVEN GEARED HEAD LATHES.

In Figs. 1 to 3 are shown the designs adopted by the Hendey Machine Co., Torrington, Conn., for its single pulley driven lathes, and for those which are to be motor driven. The forms of construction adopted present a number of interesting features. For instance, a considerable range of mechanical speed changes, nine for the larger sizes and eight for the smaller ones, is obtained from a single speed pulley by a comparatively simple mechanism. The few gears and clutches required are very liberal in size, possessing ample strength and wearing qualities to meet all the requirements of high-speed turning.

The design of the drive for the 20 and 24-inch lathes is best seen in Fig. 2, which shows the head-stock of Fig. 1 with the cover removed. The driving pulley, as shown, is mounted on a shaft at the front of, and in the same longitudinal plane with, the spindle of the machine. It carries a set of three sliding gears, which may be shifted, by means of the horizontal handle near the top of the casing in Fig. 1, to engage with any one of three gears on a sleeve which runs loosely on the spindle. The shifting gears on the driving shaft are thrown out of engagement before their position is changed by rocking the lever shown at the front end of the head-stock in Fig. 1. This rotates the eccentric sleeve in which the driving shaft is mounted, so as to move the latter away from the spindle far enough to permit the gears to be moved without interference. At the back of the gear casing is a third shaft corresponding in function to the usual back gear shaft. The two gears of this shaft mesh with mating gears on the spindle sleeve, while the pinion at its right-hand end engages the large spindle driving gear.

The handle at the front of the casing, seen in both Figs. 1 and 2, carries double cam grooves which operate two rock shafts, one of which is connected with a positive clutch on the back gear shaft, to connect the latter with either of the two driving gears on its left-hand end, while the other operates a positive clutch on the spindle, connecting the spindle with either the sleeve at the left or the large spindle gear at the right. By this means it will be seen that nine different speeds are provided, the three obtained from the sliding gears being multiplied by three by the operation of the positive clutches, it being possible to transmit the motion either directly to the spindle from the sleeve, or through either of the two back gear ratios. The arrangement of these controlling handles is very convenient. The handle on the front side of the head-stock operating the positive clutches is used for stopping and starting the machine independently of the counter-shaft. It may be so quickly done by this means that an appreciable saving of time results in cases in which frequent changes of work are required.

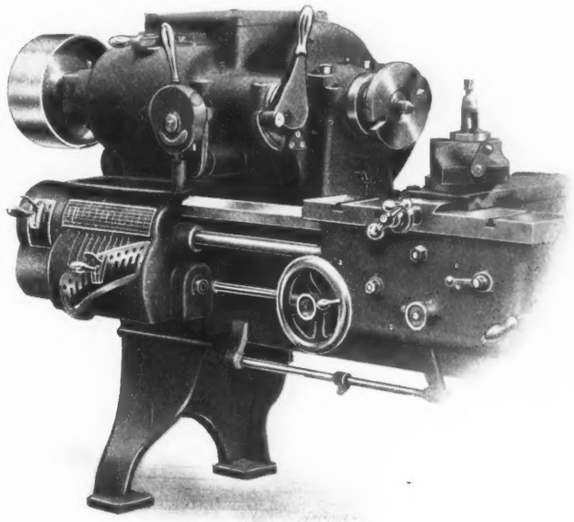


Fig. 1. Hendey-Norton 20-inch Lathe with Geared Head.

The head-stock casing forms a pan or reservoir for oil so that the gears which are enclosed are constantly lubricated. By this means they are caused to run more smoothly and they wear for a materially longer time, as well. Special attention has been given to the matter of continuous and efficient lubrication for the bearings, and for the gearing rotating freely on the shafts in the head. The spindles have taper journals running in annular bearings; and these, with the driving shaft and back gear bearings, are fitted with ring oilers, feeding from oil pockets in the casing; an exception is made in the case of the driving shaft of the 20- and 24-inch heads, which runs in babbitt-lined bearings formed in either end of the sliding gear cradle or rocker which throws the gears

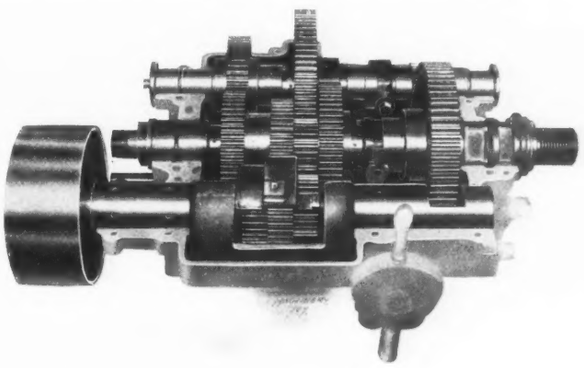


Fig. 2. The Head-stock of Fig. 1, with the Cover removed.

out of mesh, as previously explained. All bearings of the free gears and of the clutches are automatically oiled from the oil bath. The removal of the upper half of the casing, as may be seen in Fig. 2, exposes all the bearings and journals and allows the component parts of the mechanism to be freely removed.

The driving pulley is 12 inches in diameter on the 20-inch lathe in question, and is driven by a 5-inch double belt. At the highest spindle speed the belt travels 3.14 feet per revolution of the spindle, while at the lowest spindle speed this is increased to 81.5 feet per revolution. By comparing this with like conditions on a 20-inch belt cone-driven lathe, it will be found that in addition to using only a 3-inch belt in place of the 5-inch one, the amounts of belt travel are but 1.24 feet and 37 feet, respectively. The difference in belt power is

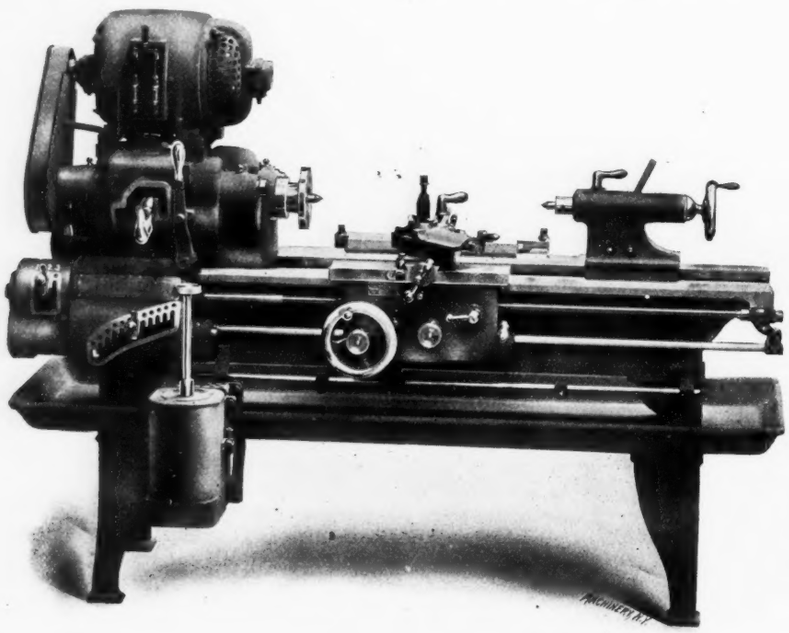


Fig. 3. Hendey-Norton 14-inch Motor-driven Lathe, showing Geared Head used on Smaller Sizes.

about 4 to 1 in favor of the geared head lathe. In all Hendey-Norton lathes, two speeds are available in the countershaft, since there is no necessity for providing a reverse drive for threading. By this means the nine mechanical spindle speeds are doubled, giving 18 in all, in geometrical progression. In the case in question this range is from 10 to 324 revolutions per minute, but may be varied, of course, to suit the class of work to be done. For motor-driven machines it is only necessary to mount the motor on top of the casing, and connect it with the driving shaft by gearing or by a chain drive.

In Fig. 3 is shown a motor-driven machine, in which, however, a somewhat different mechanism is used for obtaining the mechanical speed changes. This lathe (which is smaller than the one previously shown, having 14 inches of swing) is suitably driven by a modification of the makers' well-known change gear mechanism used in their standard line of lathes. The intermediate shifting gears, mounted on the driving shaft, are controlled by a lever working in a slot in the gear casing, which is also provided with locking holes for the plunger pin of the lever. In this head there are 4 direct speeds and 4 through the back gears with the driving shaft running at a constant rate, giving 8 in all. The large lever at the front of the head controls a single positive clutch on the main spindle, and is used to start and stop the machine in the same way as a similar lever on the 20-inch machine shown in Figs. 1 and 2. In Fig. 3 a variable speed motor is used in place of the belt transmission to a single pulley; 20 gradations of speed are provided by the controller used, so that the operator has at his control 160 possible speeds in all. By this means he may adjust the rate to give all that the cutting tool will carry within very close limits. The power transmission from the motor to the driving shaft of the lathe head is effected by a silent chain which, with the sprockets on which it runs, is enclosed in a guard as shown.

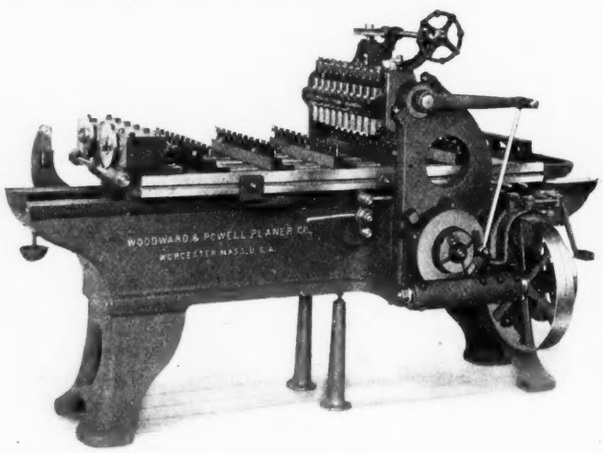
It will be seen that with either of the styles shown in Figs. 1 and 3 the mounting of the motor on top of the head is neatly done, the resulting combination not being at all top heavy. There is as well no over-hang in any direction, and the whole mechanism may be readily dismounted at any time when occasion may require. These gear-driven lathes are manufactured in all swings from 12 to 24 inches inclusive.

WOODWARD & POWELL PLANER FOR FLUTING FEED ROLLS.

We show herewith an illustration of a special planer recently built by the Woodward & Powell Planer Co., Worcester, Mass., for the special purpose of fluting feed rolls such as are largely used in textile machinery of various kinds. The construction of the planer involves a number of special features which are ingenious enough to warrant bringing the machine to the attention of our readers.

The feed rolls which are to be planed, are about 1¼ inch in diameter. The table of the planer is provided with 10 centers to accommodate 10 rolls side by side. These rolls, which are provided with square tenons on one end and corresponding square mortises on the other, are mounted on centers, those at the front end being squared to fit the mortise in the work, while the tail centers correspondingly fit the tenons. The rolls are supported throughout their length on V's, in which they are lightly held by clamps adjusted by the screws shown.

The head centers are arranged in two groups, the center spindle on each of which has a dial on the outer end. The 5 spindles in each group are geared together. These dials are left blank in the engraving, so that they may be cut with the requisite number of notches for the work in hand, the number depending on the number of grooves desired in the feed rolls. The hole in these dials is placed a little out of center, so that the space between consecutive notches will not be the same. This irregular spacing is necessary to break up the contact of the feed rolls against the leather-covered rolls they work with when assembled in the finished machine. If

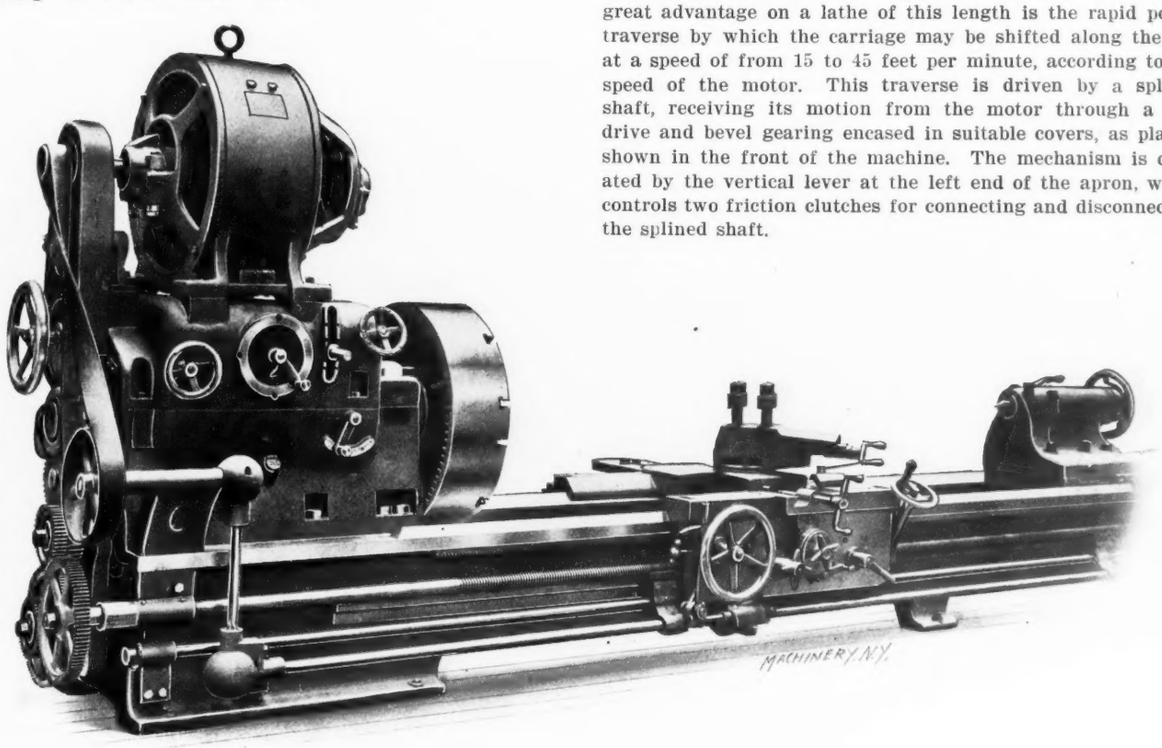


A Planer fitted with Special Work- and Tool-holding Devices for Fluting Rolls.

the notches were spaced the same, a series of impressions would be formed in the leather rolls, making gears out of them. On the horizontal shaft which runs crossways of the front end of the table are two pawls engaging notches in the dials. When the table is returning, the back end of this shaft strikes the inclined latch, shown attached to the bracket

at the back side of the bed. This latch forces the shaft over and turns the two dials, consequently turning each of the ten spindles and indexing the rolls ready to cut the next groove. When the table starts back on the cutting stroke, a spring forces the shaft back to its original position, and the end of it strikes the latch which swings to the right until the shaft is cleared.

A tool is of course provided for each of the ten rolls. These tools are all mounted in the multiple holder shown, which is fastened to a slide mounted on a frame which can be rocked on trunnions in the housings fastened to the side of the bed. The friction box usually applied to operating the feed is, in this case, used for relieving the cutters on the return stroke. The friction disk is connected by the reach rod shown with a lever attached to the rocking tool-holder, so that the cutting blades are raised on the return stroke and brought back into position again at the beginning of the cutting stroke. The tool slide in which the blades are mounted fits vertically in dove-tail ways, being adjusted by a feed-screw operated by the bevel gears and hand-wheels shown.



Heavy Bridgeford 36-inch Geared Head Lathe.

It will be seen that the table of the planer is worm driven, being provided with a belt shifting mechanism of the type commonly used on spindles. The whole arrangement is an interesting modification of a standard machine for work of a highly specialized character.

BRIDGEFORD 36-INCH GEARED HEAD LATHE.

The accompanying half-tone illustrates a new design of geared-head, motor-driven lathe, containing several features of mechanical interest; it is one of three machines recently built by the Bridgeford Machine Tool Works, Rochester, N. Y., for the Jones & Laughlin Steel Co.'s new shops at Woodlawn, Pa. One of the principal features of this lathe is that it has been designed exceptionally heavy, so as to meet the severest requirements placed on a machine of this kind through the use of high speed steel.

The drive is from a 15 H.P. Westinghouse motor, placed on the top of the frame of the geared head-stock. This motor provides a speed variation of from 300 to 900 R. P. M., and is direct-connected with the driving shaft of the head-stock through a rawhide intermediate gear. The arrangement in the geared head-stock provides for fifteen changes of speed, arranged in geometrical progression, obtainable through an easily operated speed variating mechanism in the head. The variable speed motor, however, adds to the efficiency of the tool, as it enables the operator to obtain a wide range of speeds without leaving his position at the carriage. The controller lever for the motor is mounted on the apron, and operates through a splined shaft. The controller and the resistance are placed on the back of the machine.

When the lathe is belt-driven, the speed variation obtainable through the motor is not available, but the 15 speeds provided for by the gearing in the head-stock give ample variations for different classes of work. In the case of belt-driven machines, the gear on the driving shaft is replaced by a pulley, running at a constant speed of 300 R. P. M. The spindle speeds then obtainable range from 3 to 150 R. P. M., which is sufficient for all purposes. All the driving gears within the head-stock are made of steel, and run in oil, and the bearings are so arranged as to receive a constant oil supply, thus insuring a minimum of loss of power through friction, and the durability of the tool, through the elimination of wear.

The lathe bed is 32 feet long, and a feature which is of great advantage on a lathe of this length is the rapid power traverse by which the carriage may be shifted along the bed at a speed of from 15 to 45 feet per minute, according to the speed of the motor. This traverse is driven by a splined shaft, receiving its motion from the motor through a belt drive and bevel gearing encased in suitable covers, as plainly shown in the front of the machine. The mechanism is operated by the vertical lever at the left end of the apron, which controls two friction clutches for connecting and disconnecting the splined shaft.

The lead-screw, the motor-controlling shaft and the rapid traverse shaft are all supported by automatic carriers which slide on a planed way on the front of the bed or frame. These carriers are plainly shown in the illustration; one of them always remains at the center of the travel, while the other is pushed along by the carriage. This method of supporting the lead-screw and the controlling and traverse shafts is a decided improvement over supporting them from the top of the frame, because by the former method the tail-stock is allowed free and unobstructed travel.

The lathe is designed to give a pulling power of 20,000 pounds on a 36-inch diameter, which is about four times that of the average cone-driven lathe of equal size. Motors varying from 15 to 25 H. P. are used, according to requirements. A constant speed motor can be employed instead of the variable speed motor referred to, but it is evident that variable speed is preferable. The total weight of the 36-inch lathe is about 29,000 pounds. It can be obtained with any length of bed desired, and the same type of machine is also built with 26, 32, 42 and 46-inch swing. It will be noted that in the half-tone part of the long bed has been omitted, in order to show the essential details more plainly. In the original photograph the omitted portion of the bed carries a rigid center rest, which is also furnished with the lathe.

IMPROVEMENTS IN THE UNIVERSAL MULTIPLE SPINDLE AUTOMATIC SCREW MACHINE.

Important improvements have recently been made in the driving mechanism of the multiple spindle automatic screw machine made by the Universal Machine Screw Co., of Hartford, Conn. We have previously described this tool (see New Machinery and Tools in the February, 1906, issue of MACHINERY). A comparison of the description and illustrations given in that issue with the ones here given will at once show the difference in the two designs. The new arrangement provides for a single-belt drive in place of the three-belt drive required in the older machine. Besides reducing the cost of the belting used, an important feature is the fact that it permits greater flexibility in the arrangement of the machines, gives greater driving power to the spindle, and, by means of provisions to be described later, permits of varying through a wide range the ratio between the turning and threading speeds.

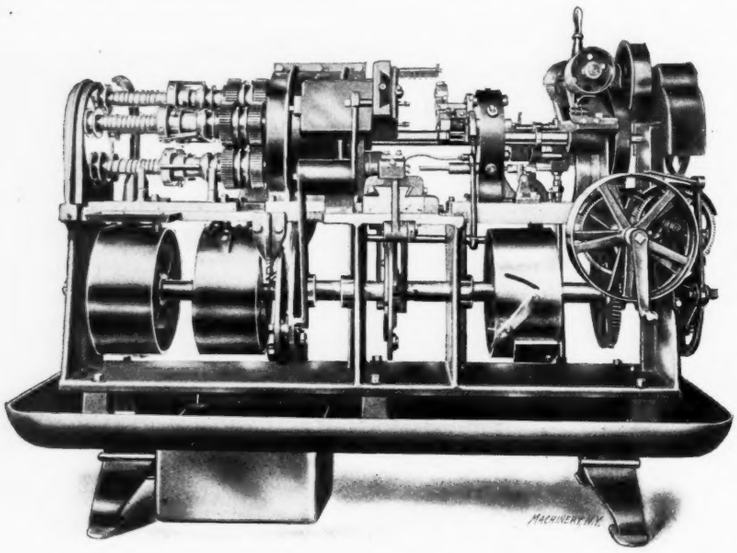


Fig. 1. Improved Design of the Universal Multiple Spindle Automatic Screw Machine.

As will be remembered, in this machine five spindles are employed, carried in a cylinder which is indexed to bring each spindle in turn opposite each of the five tool-holders, for which provision is made in the tool slide. The bars of stock which are held and rotated by these spindles project to the rear of the machine, where they are carried by reels supported by stands bolted to the floor. The tool-holder is fed forward by a cam on the cam shaft in the base of the machine, advancing all the tools simultaneously, and completing a piece of work at each revolution. The various cross-slide operations, the indexing of the cylinder, and the feeding and gripping of the stock, are also controlled by cams on the same cam shaft.

The threading is effected by reversing the spindle. The spindles normally revolve in a left-hand direction for all the turning, drilling, forming and cutting-off operations. For threading on the die, they are reversed to give a slow right-hand rotation suitable for the threading operation. When the die is advanced to the proper point on the work, the spindle carrying the latter is again reversed to throw in the regular left-hand movement, and the die is rapidly threaded off again. To obtain this alternate forward and backward rotation of the spindles in the cylinder, they are driven by two sets of gearing from their left-hand ends, of which the one nearest the turret is driven by a gear on a sleeve passing through the axis of the cylinder and leading toward the right of the machine, while the gear for driving the thread is keyed to a shaft passing through this sleeve, also extending toward the right. In the older design, this shaft and this sleeve were each driven by separate pulleys, belted to the counter-shaft. This has been changed in the new design to the method of driving shown in Figs. 1 and 2.

Sleeve *A* for driving the left-hand or turning movement, see Fig. 2, has keyed to it a gear *F*, driven by pinion *E* on shaft *D*, to which is keyed the driving pulley *C* of the machine. This driving pulley revolves at a high rate of speed, and the ratio of the driving gearing provided is such that it furnishes ample power for rotating the spindles. The right-hand end of short shaft *D* is connected by change gearing *M* with shaft *B*, which drives the spindles for the threading operation, as previously described. By this means a spindle speed suitable for threading can easily be obtained by changing gears *M*, the same as the gears for threading on a lathe are changed. The fact that an intermediate stud is introduced between *D* and *B* in this change gearing reverses the rotation of shaft *B* as compared with sleeve *A*.

The cam-shaft is also driven from the same pulley *C*. The left-hand end of shaft *D* (Figs. 2 and 3) carries a bevel pinion *G*, meshing with bevel gear *H* on shaft *I*. This shaft has loosely running upon it pulley *J*. *J* may be clutched to *I* by throwing lever *K* over, thus engaging the conical clutch surface shown. When lever *K* is thrown to the right so that the clutch is disconnected, a spring brake *L* is applied to pulley *J* which is thus instantly stopped. As may be seen in Fig. 1, *J* is to be belted to the driving pulley of the cam mechanism. It will thus be seen that the feeding and idle movements may be stopped or started independently of the spindle, greatly facilitating the setting up and operation of the machine.

Another improvement in the design is the new locking arrangement provided. Previously, the locking was done by a taper pin entering seats in the periphery of the cylinder. This has been replaced by a locking bolt of considerable size, thus giving great area of locking surface and reducing the possibility of error. This enters milled seats in the body of the cylinder, the milling being done on a fixture which has been very carefully made so as to divide these slots with great accuracy. As constructed, the upper face of the locking bolt

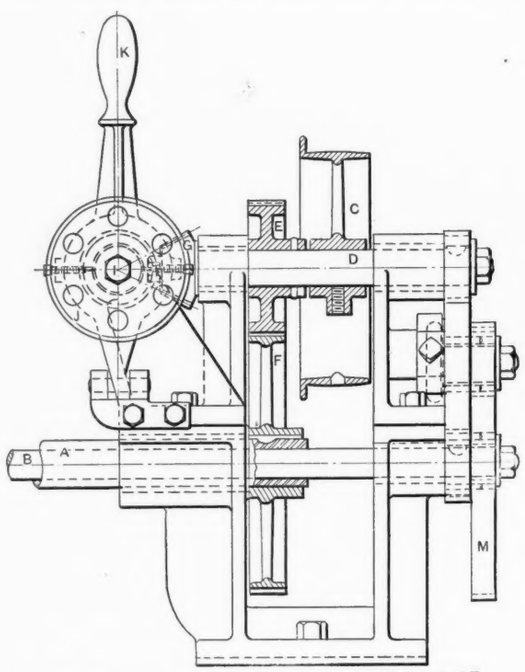


Fig. 2. The Spindle and Cam Shaft Driving Mechanism, Operated by a Single Belt.

is radial. A wedge adjustment is provided for keeping this radial face properly adjusted against the cap which confines the bolt in the slot in which it is held. The mechanism for operating the locking bolt and indexing the cylinder has been described in MACHINERY in the article previously referred to. The increased ruggedness and wearing surface given the lock-

ing bolt in this design should result in a lengthening of the effective life of the indexing mechanism.

The pump used in supplying the cutting tools with oil is also gear driven, from large gear *F* on the center sleeve. This does away with the belt drive commonly used on machines of this kind in which the belt often becomes oily and slips,

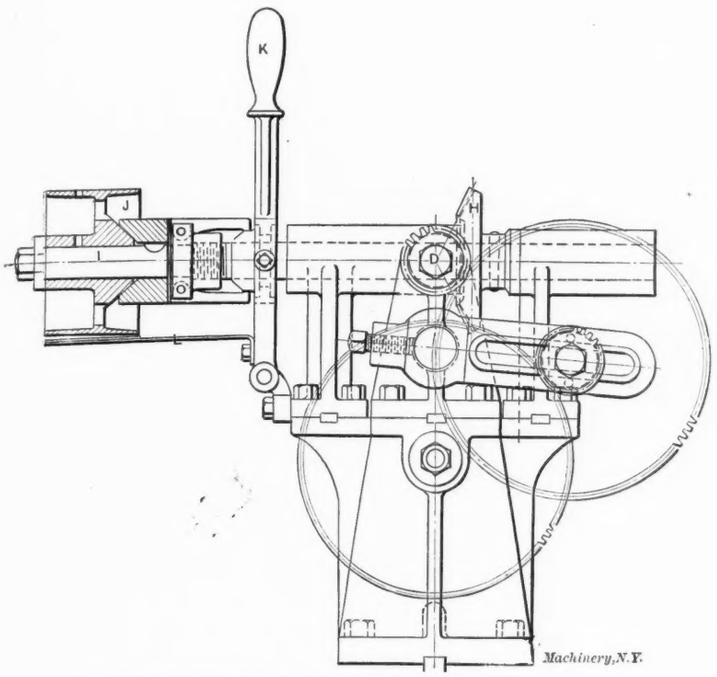


Fig. 3. End View of the Spindle and Cam Shaft Driving Mechanism.

thereby decreasing the flow of oil on the tools, resulting oftentimes in seriously heating and damaging them. Another new feature of the machine is the design of the positive clutch used for connecting the spindles with either the left-hand turning or the right-hand threading movement. We hope to publish a description of the design of these new clutches in a later issue.

The capacity of the machine shown in Fig. 1, which is the No. 3 size, allows the use of stock up to 1½ inch in diameter. It will turn up to 5 inches in length and will feed stock to 6 inches in length. Two smaller sizes are made.

TAYLOR & FENN AUTOMATIC SCREW SLOTTING MACHINE.

In the automatic screw slotting machine shown in Figs. 1 and 2 and described in the following paragraphs, the builder, the Taylor & Fenn Co., of Hartford, Conn., appears to have succeeded admirably in its attempt to design a simple and effective machine in which the possibilities of error on the part of the operator are reduced to a minimum, while the rate of production is set at the highest attainable pitch. The machine is entirely automatic in its action, and requires no attention beyond the filling of the hopper with blanks, the removal of the finished work, and the occasional sharpening of the saw with which the slotting is done.

The larger pulley at the left of the machine, driven by a constant speed belt, operates the work-holding and feeding movements. This pulley revolves on a stud, and drives a long pinion, which at the front meshes with a gear on a shaft extending beneath the bed of the machine and driving the hopper at the right, through the bevel gears shown. This hopper and the feeding mechanism connected with it, thus operate at constant speed, regardless of the size of the screw, and serve to keep full of blanks the chute leading to the work-holding disk. The principle of the feeding mechanism is the same as that employed on practically all machines of this kind. The slowly revolving hopper is filled with screws. A fork which dips into the hopper is raised from time to time to allow to slide downward into the chute, the screws whose heads have been caught between the adjustable bars which form the sides of the fork. If the chute is already filled, the blanks slide back down the fork when it is again dipped into the hopper. The raising and lowering of the fork is effected by a cam on the bevel gear shaft which drives the hopper. This cam operates a vertical rod passing through the center of the hopper which, in turn, acts on the fork through the radial bars shown. The chute is composed of a second pair of adjustable bars, which catch the heads of the screws and allow them to slide down to an escapement. This escapement, operated by cam mechanism to be described later, permits the blank to fall into position in the work-holding disk, when the proper time comes for grasping it and presenting it to the saw.

A particular feature of this feeding mechanism is the ease with which it may be adjusted for screws of different sizes. There are no parts which have to be removed and replaced for others in making changes, everything being permanently attached to the machine. Changing from one size to another is a matter simply of adjusting the distance between the guiding bars of the fork and the chute to the size of the body of the screw, and adjusting the top bar of the chute and the escapement to the size of the head of the screw.

The work-holding and cutter-feeding movements are operated from a cam shaft at the back of the machine, connected with the large driving pulley at the left by change gearing, so that the rate of operation may be altered to suit the size of work in hand. The mechanism for holding the work and presenting it to the saw will best be understood by comparing the top view of the machine, Fig. 2, with the line drawing, Fig. 3. After being released from the chute, the blank falls into the position shown at *A* in Fig. 3, where it is held between a seat in bushing *B* and spring *C*, which is attached to escapement lever *D*. This escapement lever, which thus both operates the escapement and holds the work in place in bushing *B*, is operated by cam *E* on the cam shaft at the rear

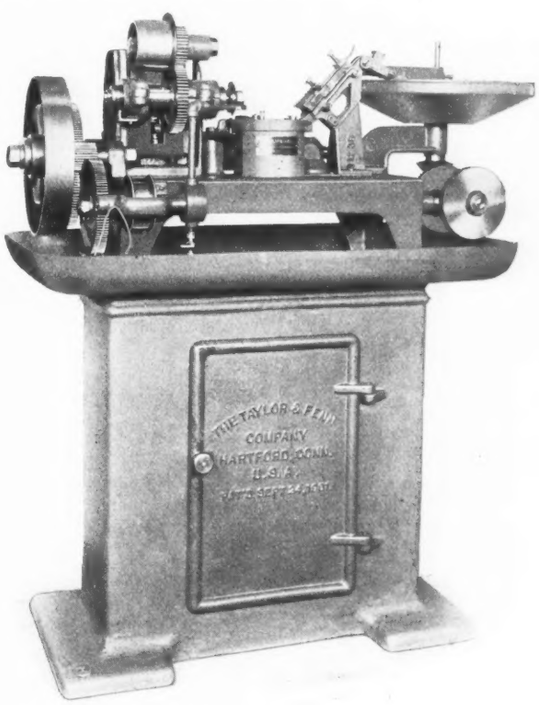


Fig. 1. The Taylor & Fenn Automatic Screw Slotting Machine.

of the machine, driven through the change gears at the left end of the machine as previously described.

At *F* is a vertical shaft extending down through the bed of the machine, driven by the bevel gears shown, from the shaft on which *E* is mounted. This shaft carries a revolving arm *G*,

which strikes locking lever *H*, pivoted at *J*, and raises it from the slot in disk *K*, in which it is seated. All these parts are shown in dotted lines, being located beneath the base of the machine. Continuing its movement, *G* strikes against the teeth of the star wheel *L* as shown, revolving it one-sixth of a turn. When this revolution has been completed, *H* again drops into the slot in *K*, locking the latter. The locking disk *K* and star wheel *L* are keyed to a vertical shaft passing up through the bed of the machine and operating turret or work-

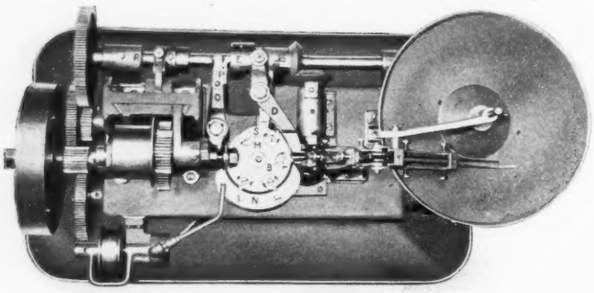


Fig. 2. Plan View of Screw Slotting Machine, showing Work-feeding and holding Mechanism.

holder *M*. As shown in Fig. 2, this work-holder carries six bushings *B*, and in its rotation receives the work from the chute and delivers it to a position directly beneath the slitting saw. The work is held loosely in place in the bushing by guard *N*, which is adjusted in or out to agree with the diameter of the body of the work.

As the work is indexed step by step around to the saw, and finally brought in position beneath it, a cam surface on the face of cam *E* operates lever *O*, whose inner end is thus pressed firmly against the work, clamping it to its seat in the bushing. Cam *E* does not bear directly on the end of the lever

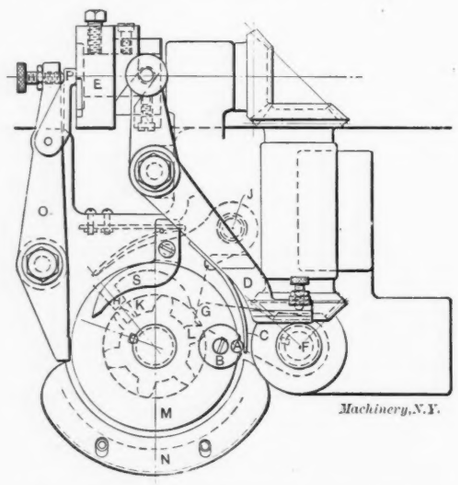


Fig. 3. Partial Plan View, showing Work-holder Indexing Mechanism.

O, but acts through the intermediate lever *P*, which is adjustable by means of the thumb screw shown. It is thus possible to regulate the pressure with which *O* bears on the work, varying the adjustment as the size of the stock varies.

The saw is mounted on a slide, gibbed to the face of a short column, and is driven by the constant speed pulley and gearing shown. It is held normally at the upward extreme of its travel by springs beneath it, seen in Fig. 1. The saw is fed down into the work by cam *Q* (see Fig. 2) acting on lever *R*. This cam operates in such a way as to bring the saw quickly down into contact with the work and feed it rapidly in, slowing the feeding motion gradually as the saw cuts to greater depth and takes a wider cut. As soon as the depth has been reached, the point of lever *R* drops off the cam and the slide flies back. Contact *P* on lever *O* then drops into the relieving space in the face of cam *E*, thus releasing the work from the bushing *B* and allowing it to drop into a chute by which it is carried to a box placed to receive it. Should the work not fall freely from its seat in the bushing, it is, by the continued rotation of the turret, finally ejected by the curved edge of ejector *S*. An oil pump is provided, as seen in Fig. 1, which keeps the saw and the work flooded so that the slotting operation can be performed at the highest possible rate.

It will be noted in Fig. 2 that bushings *B* are provided with a number of seats in their periphery. It is thus possible to provide for holding screws of a number of different sizes without requiring new bushings, as it is only necessary to loosen the screws holding the bushings and revolve them until the proper seat is brought to position to hold the work.

An important feature of the method of holding the work and presenting it to the saw is the fact that inaccuracies in indexing do not affect the centering of the slot in the head of the screw. An inaccuracy in the indexing only takes place in a direction lengthwise of the slot, and not at right angles with the face of the saw.

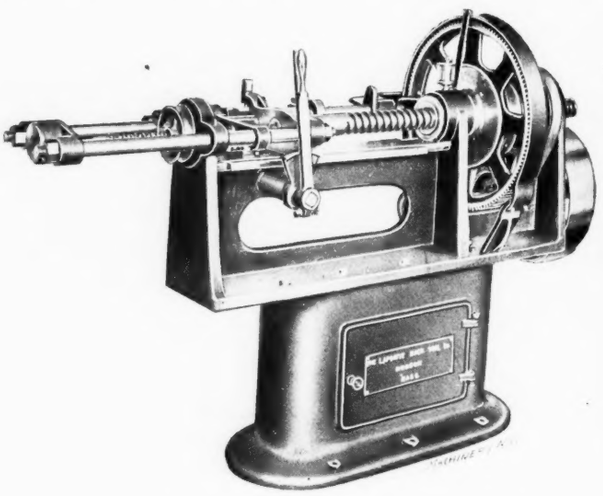
A screw adjustment is provided for shifting the spindle endwise in centering the slot, though this only needs to be done to make allowance for cutters of different thicknesses. The seats in bushings *B* are cut to such depth as to always present the screw in the same position whatever the diameter of the stock.

One of the provisions for making the machine fool-proof is the means furnished for allowing the driving pulley to slip on the hub of the pinion it drives, if any unwonted resistance is met in the mechanism. The pulley is not keyed to the pinion, but drives it by frictional contact, being clamped between collars with a degree of pressure adjusted to suit the requirements.

All gears are guarded, these guards being removed from the machines to show the mechanism better. This prevents the possibility of injury to the operator, as well as danger to the gears themselves from the accidental falling into them of screw blanks or chips. These provisions, together with the adjustability provided in the feeding and holding, should make the machine a thoroughly practical one for the work it is intended to perform.

LAPOINTE SPIRAL BROACHING MACHINE.

In the accompanying engraving is shown an ingenious modification of the well-known broaching machine built by the Lapointe Machine Tool Co., Hudson, Mass., which adapts it to the broaching of spirals, performing this operation in a very simple and effective fashion. The changes made in the design of the machine are those necessary to permit the broach to



Modification of the Lapointe Broaching Machine, adapting it to the Cutting of Spirals.

revolve freely while being forced through the work. The machine here shown should be compared with the standard design, which we have previously illustrated. (See the New Machinery and Tools Department of the July, 1907, issue of MACHINERY.

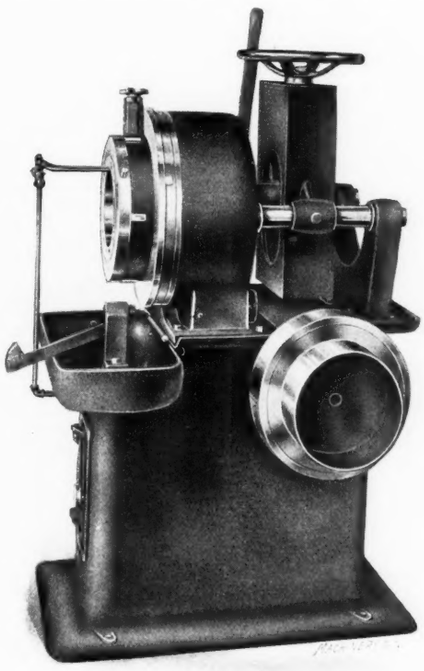
As in the standard machine, the broach is reciprocated by a ram with a screw thread cut in it, engaging a nut which

may be revolved in either direction, so as to drive the ram in or out. The reversal is effected in this machine by the shifting of belts, being controlled by reversing dogs which may be set to limit the stroke in the same way that a planer table is controlled. Instead of fastening the broach in the end of the ram and pulling it through the work, the broach is pushed, by a cross-head out in front of the machine, which is itself pulled by the two sliding rods shown, connecting it with the head of the ram. In this way the ram pulls the cross-head and the cross-head pushes the broach through the work, the latter being mounted on the front face of the bed of the machine in the same way as in the usual design. The broach is not held in a holder, but is supported on a hardened center, which thus allows it to revolve in accordance with the spiral of the grooves which the broach is to cut. The broach is revolved by its own lead, so that no complicated mechanism is necessary for obtaining the pitch of the spiral.

In the work shown, the lead of the spiral is about 6 inches per revolution. A twist considerably more rapid could be obtained if it were necessary, the limit for work of this diameter being about 3 inches lead. The number of grooves or threads makes no difference with the work of the broach. It will be seen that the arrangement is very satisfactory from the standpoint of rapid working, as neither the tools or the work have to be clamped in any way, it being merely necessary to place them in position and start up the machine. When the broach is passed through the work the operator picks it out from the bed, removes the work and inserts a new piece, proceeding as before.

THE LOEW IMPROVED VICTOR PIPE-THREADING MACHINE.

A machine embodying several new features of design which will tend to enhance the value of the pipe-threading machine, has been placed on the market by The Loew Manufacturing Co., of Cleveland, Ohio. This machine is known as the 1908 model of the Loew Victor pipe machine. The most important improvement in the design of the machine is the added strength given to parts subject to stresses, it having been the



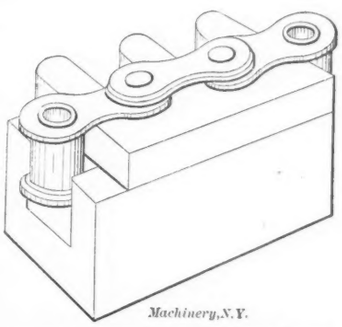
Improved Pipe-threading Machine of Heavy and Rigid Design.

manufacturer's object to build a machine sufficiently strong and durable to withstand the same hard service to which all so-called lathe-bed machines are subjected. The increase in size from previous designs is indicated by the fact that the length of the base has been increased 8 inches; the diameter as well as the bearing surface of the head has been increased; a new oil pan has also been added to the machine; and, in all, this design is about 450 pounds heavier than its predecessor.

Outside of these specific improvements, the machine contains all the special features characteristic of the Loew Manufacturing Co.'s machines in general, which may be summarized as follows: The die-head is self-locking, and holds the die absolutely rigid, without the use of wing nuts or other locking devices; the machine is provided with automatic die releasing attachment, opening the dies and removing the burrs from the thread at the same time; there is no gearing on the outside of the machine, a feature of great importance for safety as well as convenience; and a self-locking, adjustable guide is provided which holds the pipe absolutely rigid. The power required to drive the machine fully loaded is about 1 H.P. The design of this machine enables it to do the same class of work as others of the regular lathe-bed type, although it is practically only one-third of the size of that class of pipe-threading machines.

DEVICE FOR HOLDING ROLLER CHAIN WHILE REPLACING LINKS.

During the last few years roller chain drives and link belts have come into use to a very great extent where short belt drives formerly had to be resorted to. The advantages of the chain drives in such cases are well known. The chains will not stretch like the belts, and all the common troubles of belt slip, slack belts, etc., are eliminated. One difficulty with chain drives, however, has been that sometimes a link proves defective or is accidentally injured, so that it is necessary to replace this link. Repair links are always supplied, but it is not always easy with the tools or apparatus at hand to place these links in position. For this purpose the Diamond Chain and Mfg. Co., 240 W. Georgia St., Indianapolis, Ind., has placed the Diamond repair block on the market. With this tool which, as shown in the accompanying engraving, is small enough to be carried in the pocket, it is very easy to repair a riveted chain. The chain is placed in the block as indicated, and by giving both rivet heads in the link to be replaced a light tap with a hammer on a center punch, placed with its point at the center of the rivet, the old link may be detached and a new one put in its place, the chain drive being placed in action within a few minutes. This little tool will be appreciated by anybody who uses roller chain drives in any form.



Diamond Repair Block for Holding Roller Chain while replacing Links.

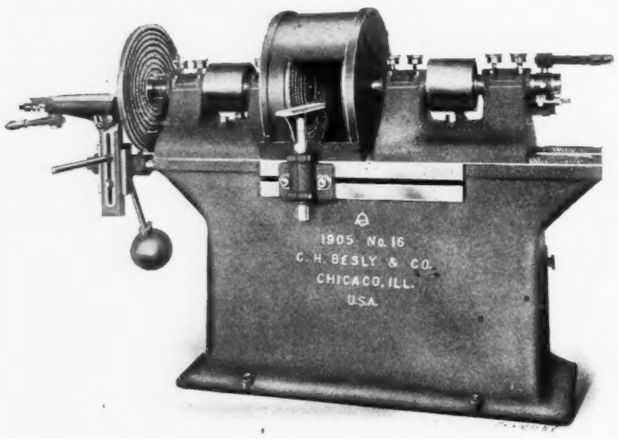
BESLY NO. 6 HEAVY SPIRAL DISK GRINDER.

This machine, built by Chas. H. Besly & Co., 15-17-19-21 So. Clinton St., Chicago, Ill., is a double disk grinder with a third disk for ordinary plain grinding at the left-hand end of the machine. This use of three disks makes the machine available for the full range of work which may be done on the disk grinder, the tool combining the advantages of both the single and double disk types.

The disk at the left-hand end of the machine may be provided with any one of the various styles of tables built by the makers. That shown is a geared lever feed table, which may be used for a large variety of grinding operations. The top is so designed that jigs and fixtures of all descriptions may readily be attached thereto. It may be clamped in a stationary position, or oscillated back and forth across the face of the disk at the will of the operator. For beveled work, it may be tipped to any angle up to 30 degrees from the horizontal position. It has a very powerful feeding mechanism controlled by an easily-operated short lever; a micrometer adjusting screw is provided for grinding to size. The bearing of the table on the shaft is very long and the thrust is

taken by collars which are rigidly clamped to the shaft, and so protected that dust and grit are excluded from the bearing surfaces, insuring long wear and continued rigidity throughout the life of the machine.

A special feature of the double disk portion of the machine is the adjustable dust hood arrangement. This is so constructed that the gap where the work is inserted between the disks, opens and closes automatically, according to the height or width of the work the machine is operating on. The parts of which it is made telescope together. The right-hand end of the hood, being attached to the movable head, is always brought into position by it, narrowing the gap or opening it



Combined Double Disk and Single Disk Grinder.

as this head is moved in toward, or away from the opposite disk. It is also hinged at the back side of the machine, so that it can be instantly thrown back, giving free access to the disks. The dust pocket in the base of the machine is so arranged as to collect naturally practically all of the waste from the grinding operation. An exhaust pipe can be attached to the rear of the base or go up through the floor directly underneath, the latter being a desirable arrangement for some cases. When connected with a suitable exhaust fan, this machine in operation is entirely free from dust. A hood is also provided for the outside wheel on the left-hand end of the machine, though this is not shown in the engraving.

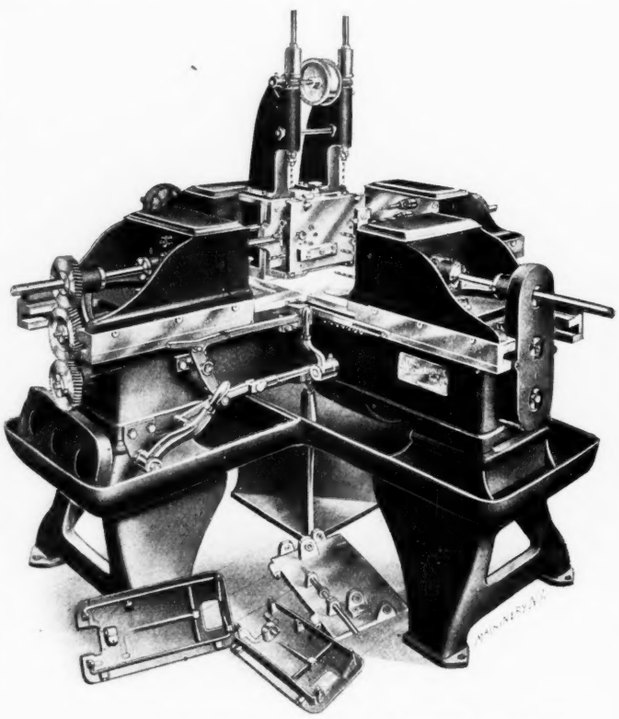
The machine as here shown, is equipped with 20-inch spiral disk wheels 13/16 inch thick. The spindles are driven by 6-inch belts at a speed of about 3,000 feet per minute, thus insuring ample driving power. The bearings are long and well protected from dust and grit. The sliding spindle is moved to and fro by rack and pinion arrangement giving the operator great leverage and making his work easy. An adjustable micrometer stop screw is provided for this movement. On the front of the base is cast a pad having a T-slot through its whole length on which the work rest brackets may be secured. Special fixtures may be fastened to the machine in the same way. The spindles are made of crucible machine steel ground all over, with special attention given to the matter of lubrication. The net weight of this machine with all accessories is 3,600 pounds. This includes work rests of various widths, a setting up press, counter-shaft and an assortment of spiral grinding surfaces. Solid wheel chucks can be furnished with this machine if desired.

NATIONAL AUTOMATIC FIVE-WAY DRILLING MACHINE.

The National Automatic Tool Co., Dayton, Ohio, is the builder of machinery which automatically performs machine shop operations on parts which are made in large quantities. We show herewith an example of its product in the shape of a five-way drilling machine, which, in the case shown, is engaged in drilling a sewing machine bed-plate having 19 holes, 5 of which are counterbored and one of which is 7/8 inch in diameter and 1 inch long. The work is done in forty-five seconds. The tool is universal and can be arranged for any other class of work.

As may be seen in the engraving, the machine is mounted on a cross-shaped bed-plate of great depth in proportion to its length and width, and heavily ribbed on the inside, making it free from appreciable deflection. This is an essential feature where combination drills and counterbores and large drills are used, and where accurate alignment between spindles and jigs is desired. This bed is mounted in an oil pan which keeps the dirt and chips from the floor, and forms a receptacle for the oil or drilling compound used. In the case shown, in which all four sides, as well as the top of the piece are to be operated on, each of the four branches of the bed is provided with a drilling head mounted on a slide, by which it is fed into the work. These drilling heads are each made up for the particular work to which the machine is set, carrying drills of the required sizes, rotated by suitable gears of the proper speeds. The work is held on a bracket in the center of the bed in a jig, to permit the rapid clamping of the work and to guide properly the various drills and counterbores used. Where holes are to be drilled in from the top, as in this case, brackets are also provided for the vertical spindles.

After the work has been clamped in place in the jig, the machine is started and the four heads are fed in toward the work by cams, one for each head. These cams, which are of the cylindrical type, give a rapid forward movement until the drills have reached the work, when they are fed in slowly to the proper depth and quickly returned again. The cam shaft stops at the end of the backward movement, mechanism being provided for this to obviate the possibility of the injury which would result to the workman if the machine should not be shut off, but should again return while he was removing the work. The cams for feeding the heads are mounted inside the four ends of the bed, and control rolls attached to adjustable bars, which may be clamped in any suitable



A Machine for Automatically Drilling Five Sides of Work made in Large Quantities.

longitudinal position with relation to the slides, thus furnishing means for adjusting the depth to which the drills are set. Power is transmitted from the rear of the machine to the several ways by means of miter gears of liberal proportions and carried to the driving shafts of the drill heads by means of twisted tooth gears and raw-hide idlers. The main driving shafts have their bearings in a sleeve which is rigidly fastened to the bed, and about which the cam drum revolves.

The removable drill heads are securely fastened and dowelled to the sides. Each is composed of two sections, dowelled together, each section being a receptacle for oil, giving thorough lubrication to the spindles, driving shaft and gears. Each spindle has three bearings and its driving gear

is located between two of them. Where long life and great accuracy of alignment is desired, spindles are made of tool steel hardened, ground and lapped. Ordinarily, however, it is sufficient to have the spindles ground all over, running in bushings of high grade phosphor bronze. All of the spindles are provided with ball thrust bearings with lock nuts at the rear to take up end motion due to wear. Idler studs are hardened and ground and supported at both ends, the gears running in the middle of the studs between two bearings.

Each removable drill box with its spindles carries its own master gear, so that by taking out the spindle driving shaft, the whole drill box may be removed and another one fastened in place for machining a new piece of work. Each spindle carries a chuck made especially for the size of the drill to be used. Morse tapers are used on all the chucks.

These machines are made in two, three and four-way designs, as well as for drilling in five directions, as shown in the engraving. The machines are universal and can be arranged for any class of work within the range of the machine. They are in use at the present time for drilling sewing machine bed-plates, phonograph side frames, gun receivers, etc.

LAPOINTE DOUBLE DRILL PRESS.

In Figs. 1 and 2 is shown a drill of novel design, made by the Lapointe Machine Tool Co., of Hudson, Mass. The novel feature of the machine, as will at once be seen, is the arrangement by which two drill spindles are mounted on the same column—not side by side as in the orthodox double-spindle drill, but on opposite sides of the column, forming two separate machines. The driving and feeding mechanisms of these two drills are so arranged that one of them is a sensitive

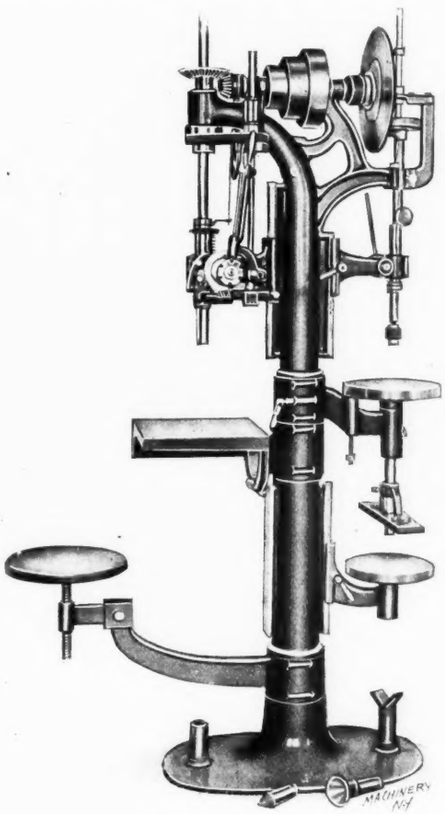


Fig. 1. The Lapointe Double Drill Press.

drill, while the other has all the conveniences of the small standard drill press. The full range of the machine provides for drilling holes up to 1 inch in diameter. It will be seen that this machine is a "double drill press" rather than a "double spindle drill press."

The two engravings show opposite sides of the machine. The sensitive drill is on the right of Fig. 1. As may be seen, this drill is of the friction type, in which the changes of speed are obtained by shifting a friction wheel across the face of the driving disk. The spindle is stopped by pushing the driving wheel to the upper limit of its travel, where it enters a recess in the face of the disk; this recess is seen in Fig. 2. The other side of the machine carries a drill spindle driven by bevel gears from the cone pulley shaft. The driving bevel pinion may be thrown out of engagement by the lever shown, so that this spindle, as well as the other one, may be

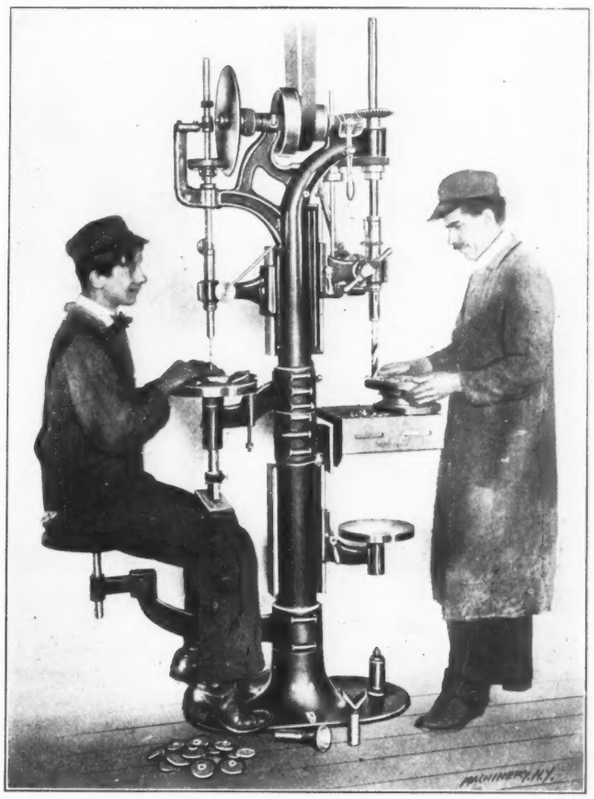


Fig. 2. The Drill Press in Action, the Knee Feed being used by Operator on the Left.

stopped independently of the driving shaft. This spindle is carried by a sliding head, and is provided with power feed, a lever feed and a quick return. An automatic stop is also incorporated in the mechanism. This is seen best in Fig. 1.

A variety of work tables is provided. Any one of these may be used with either of the two spindles, so that a great range of work is provided for. At the left of Fig. 1 is shown a rectangular work table, which may be swiveled to any angle about a horizontal axis. It has a narrow clamping surface on its side, as well, for the work which is more conveniently held in such a position. At the left of Fig. 2 the round table is shown in use. This is being fed to the drill, in the case shown, by the knees of the workman, who sits on a stool which is part of the equipment of the machine. This arrangement allows both hands to be used for the insertion and removal of work, and in the case of small pieces and quickly drilled holes thus materially increases the product of the machine. Besides this, a second small round table is provided, on a bracket sliding on ways on either side of the column. The latter table may be removed and a V-block, a pointed center or a cup center used in its place. The latter parts may also be inserted, as shown, in sockets provided for them in the base, when it is desired to center long shafts or do other similar work.

Aside from the compactness obtained by incorporating two machines in one, this design gives the advantage of providing an unusually large combination of work tables and holding devices, permitting work of any kind to be done in the most satisfactory manner. The arrangement of the tables and the spindles is such that the work can be clamped on the sensitive drill side, for instance, and have a hole drilled in this position, and then be swung around to the opposite side to counterbore or drill a larger hole with a heavier drill. This may be done without unclamping the work.

AN AMERICAN MECHANIC IN EUROPE—2.

THE SECOND OF A SERIES OF LETTERS FROM OSKAR KYLIN ON THE EDITORIAL STAFF OF MACHINERY.

Nuremberg, April 15th, 1908.

During the time which has elapsed since the writer's previous letter, he has met all the prominent machine tool dealers in Berlin, Magdeburg, Leipzig, and Chemnitz, who have freely given their views in regard to the present business conditions in Germany. It may be said, in general, that the machine tool trade has improved somewhat during the last month. All large dealers seen during the last week of February reported business dull throughout the machine tool field, but, with a few exceptions, all the dealers whom the writer has come in contact with during the last two weeks have reported conditions brighter and business better. One dealer in Dresden said that he had done a good business during March.

One difficulty of the American machine tool trade in Germany seems to be that the German user wants to get machines exactly according to his own preconceived ideas, and is not willing to vary these ideas to suit the manufacturer's standard models and designs. This creates a demand for many special designs which the manufacturers here have to meet, and it prevents the German machine tool builders from going far into the specialization of their product. At the same time it is a serious drawback in the selling of American machinery. This condition has been responsible for a new departure in the policy of many German concerns, which originally did not make machine tools, but which now have their own departments for making all the tools they themselves use. This, of course, takes away a large part of the work from the firms specializing in machine tools.

Decentralization of Machine Industries.

Regarding the location of the large machine shops, the same conditions are visible in Berlin as are in evidence in New York, London, and many other large American and European cities. As the population of a city increases, the centrally located portions become crowded and overpopulated, so that the ground rent becomes higher, and with it, as a matter of consequence, the price of land, the cost of living, and the cost of labor prices. Because of this, many industrial concerns, especially the larger ones and those developing most rapidly, have established plants in the suburbs, where land is cheaper, and where ample space is available for present needs and future expansion. The cheaper price of land makes the living expenses for the employes smaller, and they are therefore able and willing to work for smaller wages than they could accept when forced to either live in the city, or to pay railroad fares to and from the factory. At the same time the employes live a more comfortable and pleasant life in the suburbs, in spite of their nominally smaller earnings.

Works of the Firm of A. Borsig.

A direct example of this condition is that of the works of the firm of A. Borsig, Berlin-Tegel. These works were, up to a few years ago, located in Berlin, but as the premises became too crowded, the works were moved to Tegel, a suburb a few miles out from Berlin. This plant has grown so that it now employs about 6,000 men throughout the various departments. In addition to the Tegel plant, this firm has one plant in Oberschlesien, where about 1,200 men are employed. This latter plant consists of a steel mill, with blast furnaces, rolling mills, etc. All the raw materials, cast iron, steel, sheet iron, boiler plate, etc., which are required in the various kinds of manufacture in the Tegel plant are taken directly from the works in Oberschlesien.

The principal product of the Borsig plant is locomotives, but boilers, steam engines, pumps, and refrigerating machinery are also built. Up to a short time ago this firm also built the Oechelhäuser gas engine, but, as there was not enough commercial return to warrant the building of these engines, the firm has discontinued this line of manufacture. The gas engine industry, in general, seems to be waning at the present time in Germany. It is not as lively now as it has been for a few years past. It was interesting to notice the extent to which portable machines were used in the Borsig works. Such machine tools as drills, milling machines, and riveting machines, with the exception of the largest and heaviest ones, are all portable and mounted on wheels, so that they can be easily moved from one place to another, enabling the finishing of large pieces of work without the expense and difficulty of moving large boilers or heavy locomotive frames. The floors are all made of concrete, as this facilitates the movement of the portable machines, and in the concrete floor are embedded a large number of tracks running in different directions for accommodating small trucks. The portable machine tools in this plant are partly electrically, and partly pneumatically, driven, and are equipped with devices by means of which they can be fairly well secured to the floor, so as to enable the tools to work with the greatest possible efficiency.

Interesting Use of the Oxy-hydrogen Blow-pipe.

The use of the oxy-hydrogen blow-pipe method for cutting steel is not fundamentally new to technical men, as this method and various applications of it have been described from time to time in the technical press. The following use of this appliance in the Borsig works, however, is rather novel, and should be of particular interest to the readers of MACHINERY. The accompanying engraving shows the outlines of a connecting-rod. This rod is first forged and the two side surfaces

Connecting-rod from which Surplus Metal is removed by the Oxy-hydrogen Blow-pipe Method.

are planed, after which the connecting-rod has an outline as represented by the full lines. Now lines are scribed on the connecting-rod as shown by the dotted lines, and a heavy punch-mark line is made a trifle outside of the scribed lines. This line is followed by the blow-pipe gas jet, and a slot about 1/8 inch wide is thereby cut through the rod, leaving for finishing about 1/16 to 1/8 inch. All the surplus material is removed in this manner, and the surface left from the cut is fairly smooth and true. For locomotive connecting-rods of medium size, the time required for cutting the length shown at *AB* is about 2 to 3 minutes. The apparatus for applying the gas flame to the work consists of a plain nozzle connected to a flexible pipe, with the apparatus mounted on two small wheels, which makes it easy for the operator to apply the jet exactly where wanted, and to get the cut square with the planed surface. The edges of the connecting-rod are afterwards finished by milling.

Use of Magnetic Chucks.

Prominent German machine builders make extensive use of magnetic chucks. The writer saw in particular a large number in use in the shops of Ludwig Loewe & Co., Berlin. For small work particularly, when quick clamping is of importance and comparatively small power is required to hold a piece of work in position during the operation performed on it, the magnetic chucks have there found a wide field of usefulness. On machine tools there are many small parts like washers, sliding pieces, etc., having flat surfaces, which, for the sake of accuracy and smooth finish are required to be finished by grinding. To clamp such pieces in ordinary chucks is usually difficult and slow; in such cases the magnetic chucks are always used. As is well-known, when finish-grinding but very little power is required to hold the piece of work in place, and the magnetic chuck does not need to have a very high holding power, so that a piece of work may even be removed by hand without disconnecting the current. The current is taken from ordinary lamp sockets.

German Foundry Practice for High Grade Castings.

The casting of cylinders for automobiles is considered to be one of the most difficult problems that the foundry man has to deal with. The casting must be of the very best material, and, as far as possible, be free from blow-holes and other defects, because of the high temperature and pressures on automobile cylinders. A prominent German firm, which makes a specialty of casting automobile cylinders and is considered as turning out a very high grade article, places spe-

cial emphasis on the importance of the design and the making of the cores for obtaining good and sound cylinder castings. As these cores are very small, the problem of making them is a rather difficult one. The sand used for making the cores is of a rather coarse grain, and for binding purposes dextrin is employed. This produces a very strong and hard core. For making the vent holes in these small cores a tallow-coated thread is put in the center (or wherever wanted). When the core is heated for the purpose of drying, the tallow melts, and the thread can be pulled out, leaving behind it a very small vent hole. The gases produced when pouring the metal have an easy access to the vent hole, due to the coarseness of the sand, and pass through the vent hole out into the atmosphere. Resistances for electric apparatus which are only about 3/32 inch thick are cast by using cores made on similar lines.

General Observations on the Machine Tool Industry in Berlin.

The leading machine tool building concerns in Berlin are the firm of Ludwig Loewe & Co., and the Deutsche Niles Werkzeugmaschinen-Fabrik, Oberschoeneweide, near Berlin. In order to avoid undue and unnecessary competition, these two concerns are working under a trade agreement, so that the former one is specializing on small tools and machine tools of small and ordinary sizes, and the latter concern is devoting itself to large heavy machine tools. A short time ago the Deutsche Niles Werkzeugmaschinen-Fabrik built a giant planer, which in size and working capacity is claimed to have been superior to the one recently built by the Bement-Miles Works in Philadelphia. This large German planer was built for a German turbine building concern. [The Bement-Miles planer was described in the January, 1908, issue of MACHINERY.—EDITOR.]

In addition to the two large concerns mentioned, there are in Berlin a great number of smaller ones, employing all the way from 25 to 150 men. A few of these have already followed the American practice of specializing on certain types and kinds of machine tools, but the large majority of them are building any one particular machine which they think will sell best at the moment, be it shaper, lathe, gear-cutting machine, or any other kind of machine tool. Although these concerns are not, according to American ideas, strictly up to date, they are still filling a certain want. They make the cheap grade of machinery required by many small manufacturers, who cannot afford to pay the price of, or do not need, a strictly first class type of machine tool. These small firms seem to be reasonably prosperous.

The Machine Industry in Magdeburg and Dresden.

A concern which is well-known for good workmanship, and for the high efficiency of its products, not only in Germany, but all over Europe, is the firm of R. Wolf, of Magdeburg-Buckau. This firm originally built only portable steam engines, but having had great success in this business, the building of larger stationary steam engines of the same type as the portable engines was also taken up. It may be mentioned in this connection that in Europe stationary steam engines are often used which are built entirely along the lines of the type of engines known as portable in the United States, though they are installed for stationary use in manufacturing establishments. These larger stationary engines of the portable type are now built in units up to 600 H. P.

Through the introduction of an improved design of superheated steam, compound, condensing, portable engine, a point of efficiency has been reached, which, as a rule, is attainable only in units of very large size. A 50 H.P. engine, recently built, consumed during the test run only 1.12 pound of coal per H.P. hour, and in a 100 H.P. engine of this design the firm has brought down the consumption to one pound of coal per H.P. hour. [This is as low a coal consumption as is attained by triple or quadruple expansion condensing engines on large ocean-going steamers.—EDITOR.] The old shops of this firm in Buckau have proved too small for the amount of business done at the present time, and a large new plant is being built some distance out from the city. This new plant, which will be of the most modern construction, is to be used for the building of large stationary engines of the portable type, while the old plant will be used for building small sizes exclusively. The new shops are located alongside the railroad, and are arranged so that all the raw materials, castings, etc., will enter the shop at the end farthest away from the railroad, and the finished engines will be assembled, tested, and made ready for shipment, at the end nearest the railroad, where they can conveniently be loaded directly on the railroad cars.

The machine tool industry in Magdeburg and Dresden is largely represented by a few small concerns belonging to the same class as the small concerns in Berlin, previously mentioned. The Dresdner Bohrmaschinenfabrik, Dresden, however, is an exception to this rule. This concern employs about 300 men, and makes a specialty of drill presses and chucks, and the specialization of these tools has been carried to a high degree of perfection. The unit principle of design has, in particular, been highly developed in their machines. The units are manufactured independently of the completed machines, for which they are intended, and are often made in lots of 100 at a time, and kept in stock until needed for assembling purposes. The same detail units are often used for several different types of machines, a feature which is highly important in bringing down the labor cost in specialized manufacture.

Chemnitz—a Center of Machine Tool Industry.

During the last few decades Chemnitz has succeeded in establishing itself as one of the largest and most important centers of the machine industry in Germany, and this in spite of its location far from navigable rivers, and its lack of water power. At the present time, Chemnitz, according to the United States Consul in that city, exports more machinery to the United States than any other German city, Berlin not excepted.

Nearly all branches of machine industry are here represented. One of the largest locomotive works in the world, the Sächsischen Maschinenfabrik, is located here, and is, as regards size, the leading concern. In addition to a large locomotive department, this firm has departments for steam engines, boilers, steam turbines, and machine tools, principally those of heavy design. One branch of the machine industry that has largely helped to give Chemnitz a well-known name is machinery for various uses in the textile industry, most particularly knitting machinery. These machines require a high degree of precision work, and their manufacture necessitates the designing and using of many special machine tools. This fact has forced, or, at least, greatly encouraged, some concerns originally only making textile machinery to add a department for the manufacture of machine tools. An example of this is the firm of Schubert & Salzer. The machine tools obtainable in the market could not entirely satisfy their needs, and therefore they were forced to make all special tools themselves. Having once started in this line of business, when the demand for high grade machine tools increased, they extended this department, and commenced to make machine tools for the market.

The manufacturing of machine tools occupies now one of the foremost places in the Chemnitz machine industry. Here are located concerns engaged solely in machine tool manufacture, employing up to 2,000 men, making strictly first-class machinery, and there are also a large number of concerns with from 25 to 50 men, many of whom make only cheap grades of machines. All kinds and sizes of machine tools are being built here, from the large and heavy machines built by the Sächsischen Maschinenfabrik down to the very smallest machines for fine precision work.

The Reinecker Works in Chemnitz.

The firm of J. E. Reinecker is one of the leading concerns for the manufacture of high grade machine tools of all types. This firm has also a large department for small tools. It was founded by J. E. Reinecker in 1859, and was, at first, only a very small concern, devoting itself to the making of machine tools. The development of the firm has been rapid, and 2,000 men are now employed in the shops. Although this firm builds all kinds of machine tools, the specialties given most attention are the most commonly used sizes of plain and universal milling machines; milling machines of the planer type; heavy duty relieving lathes, grinding machines—especially tool grinders; and gear-cutting machinery.

The department for gear-cutting machinery is highly developed and would deserve more than incidental mention. A large variety of machines are manufactured for cutting bevel gears, spur gears, worms, worm-gears, and racks. The Bilgram bevel gear planer is manufactured by the Reinecker firm for the European market, and its excellent design and workmanship has gained for it a high reputation and a large number of users. Careful methods of selling, and of placing the machines in the customers' shops, must also be given some credit for the success. In most cases, a competent man is sent with the machine sold to teach the buyer to use the machine to best advantage, to the great satisfaction of the customers. A great deal of the success of this department is due to the energy of, and the work done by, Mr. August Hoffman, an American, who introduced the Bilgram bevel gear planer in Europe, and who is in charge of the gear-cutting machinery department of the Reinecker firm.

Schubert & Salzer and other Chemnitz Machine Tool Builders.

The firm of Schubert & Salzer, as previously mentioned, originally specialized in building textile machinery, but they now, in addition to these, make also cash registers and machine tools. It has also already been referred to that, by the force of circumstances, this firm was carried into the manufacture of machine tools. It should, however, also be mentioned that, according to their own statement, one reason for this was that they found the American machines which were formerly largely employed in their shops, with a few good exceptions, too weak for their material and kind of work. This was one of the causes that forced them to make ordinary machine tools. They are now, in addition to making all their own special machines, devoting themselves to milling machines, drill presses, and planers which are designed to have a number of cutting tools working simultaneously—in some cases, as many as six. The Wanderer Fahrradwerke began the manufacture of machine tools for reasons similar to those mentioned in the previous case. This firm originally engaged solely in the bicycle industry, but later added a department for typewriting machines and machine tools, and is now carrying on all these three lines of manufacture. In addition to making the machine tools for their own special purposes, they have specialized in milling machines and gear-cutting machinery.

As mentioned about small Berlin firms, there are also in Chemnitz a large number of small concerns which have not specialized on any particular kinds of machine tools, but are making any kind required. A small concern which constitutes a remarkable exception to this rule is the firm of Messdorf & Mehnert. This firm employs about 150 men. Up to a few years ago all kinds of machine tools were built, and not less than four different designs of gear-cutting machines were manufactured; now, however, nothing but certain types of milling machines are built.

Secrecy in the Trades.

The German machine manufacturing concerns have gained the reputation of keeping what they choose to call "trade secrets" with a jealous zeal, and they are claimed to object to any visitors in their shops, because of fear that these would carry away with them some valuable suggestions or new designs of special tools, or whatever it may be that they call trade secrets. Whether this reputation be justified or not is perhaps difficult to say. The writer's experience regarding this has been that large well-known concerns, well equipped with new modern machine tools and employing up to date methods, and making and turning out a first class product, are the ones who least object to visitors in their shops, but the old, conservative concerns with ancient tools and methods do not "for their life" allow anybody to visit the shops under any conditions. In many cases the writer has succeeded in learning something about the concerns which, from principle, never allow any visitors, and he has seen some of their machines either in the stock rooms of machinery dealers, or in other shops, and he has found indications of the truth of the above statement. On one occasion the writer was refused permission to visit the shops of a certain concern because, as they said, they had so many special things which they did not want anybody to see. The same day he had occasion to meet a gentleman who was well acquainted with the shops referred to. Upon hearing of their refusal to allow him to visit the shops, he said: "You did not miss much, but you saved your clothes from being spoiled by dirty oil, dripping down from the counter-shafts and hangers."

Criticisms of American Machine Tools.

In my previous letter I mentioned that American machines and tools were too weak for the German demand. A dealer who handles both American and German machinery to about the same extent, and who, therefore, can be considered as impartial on the subject, gave a few statements as to which parts usually suffer from lack of strength, and which are not made by manufacturers according to the requirements of German buyers.

The American plain face-plate is not accepted in Germany. German dealers, in order to sell American machines, many times at their own expense substitute German chucks for the plain face-plates on American lathes.

Tool-posts on lathes are often made too weak. Heavier turning tools are used in Germany, and sometimes the American tool-posts are not large enough to take these tools.

The speed boxes on the drill presses and on milling machines are not made strong enough, and, besides, the German buyer objects to cast iron running with cast iron in gearing. He prefers to have cast iron gears meshing with steel gears.

As a personal opinion, the dealer from whom the writer obtained this specific information, expressed the idea that if the American manufacturers would simply meet these requirements of the German buyers, the American foreign trade in machine tools would be greatly benefited thereby, and would gain considerably more ground in Germany.

* * *

EXPOSITION OF SAFETY DEVICES.

The American Institute of Safety Devices and Industrial Hygiene, a sub-organization of the American Institute of Social Service, has opened an exposition of safety devices on the fifth floor of the new building of the McGraw Publishing Co., 231 W. 39th St., New York City. The exposition was opened on April 13, and will remain open until June 1. It is free to the public, and open from 10 A. M. to 6 P. M., except Sundays. The exposition embraces all kinds of safety devices employed in manufacturing, mining, transportation, and in electrical and chemical industries. Some of the exhibits are of special interest to machine tool builders, in particular some selections of large photographs from the Brown & Sharpe Mfg. Co., and from the various plants of the Niles-Bement-Pond Co., showing installations for safeguarding the workmen in these establishments, as well as machines built by these companies, provided with proper guards over gearing, emery wheels, etc. There are very few actual exhibits as yet of safety devices pertaining directly to the machine tool trade. A number of photographs are shown, giving interior views of the prominent museums for safety devices in Paris, Berlin, Munich and Vienna, as well as photographs of safety devices employed in the industries in Europe.

Some of the exhibits appear to be more of an advertising nature than embodying actual safety devices, and as long as the space permits the exhibits of objects of this kind there can be no objection to their presence, but in case the interest shown by our manufacturers in this exhibit should be large enough so that the space allowed became limited, it might be suggested that exhibits which appear to be of a commercial nature, rather than embodying an interest in the safety of American life and labor, should be carefully scrutinized. The aim which the Institute of Social Service has in view is to increase the realization among our American people of the terrible tribute paid annually in our industries in the form of loss of life and limb of our workers, and to arouse a public spirit which will demand that proper safeguards be placed around the industrial worker, so that his risks may be lessened as much as possible. Most of the 500,000 industrial accidents, which annually occur in the United States alone, could be prevented without great expense, simply if the general public became fully aware of, and interested in, the possibilities of safety appliances in various forms.

MISCELLANEOUS FOREIGN NOTES.

ITALIAN IMPORTS OF MACHINERY.—Figures published by *La Métallurgie* indicate that in 1905 the imports of machinery into Italy from Germany had a value of about $12,000,000. The value of the machinery imported from Great Britain had a value of about $7,000,000, and from France, $1,300,000. The value of the imports of machinery from the United States is not mentioned in the table published by the journal referred to.

MACHINE TOOLS IN TURKEY.—The increase of railways in Turkey and its possessions, and the general impetus given to trades in general, has caused a demand for machine tools. The conditions of the country, however, are peculiar, and, at present, the greatest demand is for small machines driven by foot power, but the increase in the use of machine tools has also increased the need and demand for motors of various kinds, and it is likely that machine tools of ordinary descriptions will soon find a market in the country.

GERMAN IMPORTS AND EXPORTS.—The figures for the imports and exports of Germany during the first month of the year indicate that its foreign trade was depressed, and that business conditions were not satisfactory. The imports dropped from 4,194,000 tons for January, 1907, to 3,644,000 tons for the same month, 1908. The exports dropped from 3,264,000 tons to 3,168,000 tons. In January, 1906, the imports and exports were 4,578,000 tons and 3,611,000 tons, respectively, so that there has been a steady decline in foreign trade for the last two years.

DEMAND FOR AMERICAN AGRICULTURAL MACHINERY IN SWEDEN.—According to *Engineering*, the Swedish government lately sent a special agent to the United States and Canada for the purpose of examining and studying such agricultural implements and machinery, used in these countries, as might be suitable for the conditions in Sweden. A report has been forwarded to the government, in which it is proposed that the state should appropriate a certain sum for the purchase and thorough testing, under proper supervision, of such implements.

MACHINERY BUSINESS IN GERMANY.—The past year appears to have been exceptionally profitable to the German machine builders. The Gritzner Machine Co. reports a profit of 888,500 marks ($215,000)—a considerable increase over the previous year—and is paying 15 per cent dividends. The Wülfel Iron Works, Hanover, are paying 10 per cent. The East German Machinery Company, Heiligenbeil, is paying 9 per cent, and most firms show considerably higher profits for the past year than for the year previous. However, recent reports indicate a falling off in the trade, even if this falling off is not serious enough to cause any anxiety on the part of German machine builders.

CHINESE EXPOSITION.—Consul-General W. Roderick Dorsey reports that it is proposed to hold an exhibition in Shanghai during 1909, under the name of The Shanghai International Exhibition. This exposition will be confined to staple manufactures and machinery. The project is as yet, not fully worked out, and it is impossible at the present time to secure any particulars as to the space available for different exhibits, or the terms on which space may be rented. Seventy acres of land, however, have been secured in a suitable location. American manufacturers and exporters interested may secure further information as soon as available by addressing Mr. L. E. Canning, Secretary China Association, 6 Peking Road, Shanghai, China.

GERMAN TRADE CONDITIONS AND THE TACTICS OF THE GERMAN STEEL TRUST.— It is understood that the manner in which the German steel trust treats its customers has caused considerable opposition. The steel trust is said to control 95 per cent of the iron and steel output of Germany, and consequently dealers and buyers are completely at the mercy of the combination. The trust leaves to each dealer only a very limited territory, and insists upon being supplied with the names of the buyers, the prices, and all particulars concerning the sale. The dealers are therefore somewhat apprehensive of the fact that this might mean that the trust will finally do its business directly. This, of course, would not impose any hardship on the German industries as such, for direct dealing is as a rule always preferable to dealings through intermediate agents, but the manner in which the trust goes about to accomplish its purpose seems rather arbitrary. It is also complained that the trust charges higher prices in such parts of Germany where it is difficult for foreign steel to compete on account of the longer shipping distance by rail. It is stated, however, that the steel industry itself is not in as prosperous a state at the present time as before the renewal of the syndicate. Thousands of employes have recently been dismissed by works belonging to the trust. Krupp's works alone have reduced their force by about 3,000 men. The German motor car industry, which held its own rather longer than that of France and the United States at the time when the inevitable reaction came, also commences to show signs of depression.

* * *

A novel feature of the coming Master Mechanics' Convention at Atlantic City will be the exhibit of the Committee on the Apprenticeship System. It is expected that all the railroads operating apprentice schools will send models, drawings and photographs to show in a comprehensive manner the rapid advancement which is being made in this phase of railroad activity. The Central Railroad of New Jersey, the Grand Trunk, the New York Central Lines, and the Santa Fe have already arranged to exhibit.

* * *

SPRING MEETING OF THE A. S. M. E.

The semi-annual meeting of the American Society of Mechanical Engineers will be held in Detroit, Mich., June 23-26. Among the papers to be presented at this session are: "A Method of Cleaning Gas Conduits," by W. D. Mount; "A Method of Checking Conical Pistons for Stress," by Prof. George H. Shepard; "Clutches," with special reference to automobile clutches, by H. Souther; "Horse-Power, Friction Losses, and Efficiencies of Gas and Oil Engines," by Prof. L. S. Marks; "Some Pitot Tube Studies," by Prof. W. D. Gregory; "The Thermal Properties of Superheated Steam," by Prof. R. C. H. Heck; "A Journal Friction Measuring Machine," by Henry Hess; "A By-Product Coke Oven," by W. H. Blauvelt; "Tests of Some High Speed Steam Engines," by F. W. Dean. There will be a symposium upon machinery for conveying materials, with papers by several authorities. The Society for the Promotion of Engineering Education and the Society of Automobile Engineers will also hold their annual meeting in Detroit at this time, which will enable members of each society to participate in the sessions of the other.

* * *

THE MACHINERY CLUB.

The new quarters for this club in the Hudson Terminal Building are nearly completed, and it is expected will be ready for occupancy soon after May 15th. The intention is to open the rooms with a formal reception which will be held about May 20th. The total membership to date is nearly nine hundred. The officers of the club are as follows:

Officers—F. H. Stillman, president; R. C. McKinney, vice-president; Walter L. Pierce, treasurer; W. Seton Henry, Acting Secretary.

Governors—O. C. Gayley, Pressed Steel Car Co.; George A. Post, Standard Coupler Co.; Walter L. Pierce, Lidgerwood Mfg. Co.; F. H. Stillman, Watson-Stillman Co.; C. A. Moore, Manning, Maxwell & Moore; H. L. Shippy, John A. Roebling's Sons Co.; T. N. Motley, T. N. Motley & Co.; Henry Prentiss, Prentiss Tool & Supply Co.; H. B. Kirkland, National Metal Molding Co.; W. P. Pressinger, Chicago Pneumatic Tool Co.; A. B. See, A. B. See Electric Elevator Co.; W. H. Marshall, American Locomotive Co.; R. C. McKinney, Niles-Bement-Pond Co.; E. H. Wells, Babcock & Wilcox Co.; W. L. Saunders, Ingersoll-Rand Co.; Otis H. Cutler, American Brake Shoe & Foundry Co.; J. R. Vandyck, Vandyck, Churchill Co.; Kenyon B. Conger, Hudson Companies; Wm. B. Albright, Sherwin-Williams Co.; Chas. A. Schieren, Jr., Chas. A. Schieren & Co.

Executive Committee—F. H. Stillman, Chairman; R. C. McKinney, Walter L. Pierce, Geo. A. Post, Henry Prentiss.

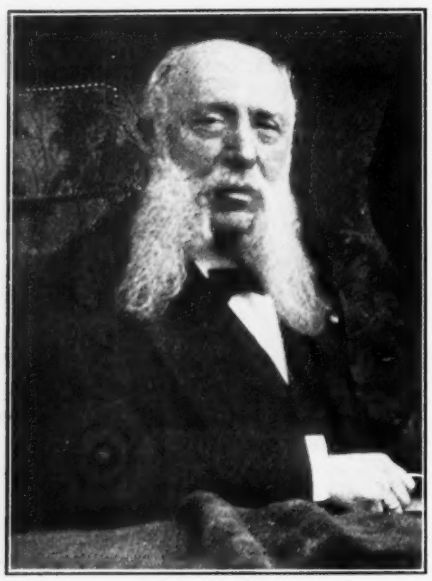
House Committee—T. N. Motley, Chairman; Chas. A. Schieren, Jr., Percy A. Ware, Geo. Howells, Edward H. Benners.

Membership Committee—J. R. Vandyck, Chairman; Geo. L. Gillon, Chas. B. Crook.

* * *

A WELL-KNOWN DUTCH TRADING HOUSE, AND ITS HEAD.

One of the largest trading houses in Europe, and one that is of considerable importance to American machine tool builders is that of R. S. Stockvis & Sons, Rotterdam, Amsterdam, Brussels, and Java. This great house was founded by R. S. Stockvis in 1844, and three generations of the family have contributed their energies to putting it in its present high position. The main warehouse and the offices of the company are in Rotterdam, where they have a long frontage on one of the principal canals, the Leuvehaven. They cover a superficial area of 776,000 square feet, and most of the buildings are five or six stories in height. The stock on hand has a mean value of never less than $1,250,000. It consists mainly of machine tools and lighter articles of hardware merchandise. Although the machine tool business is one of the recent activities of the concern, it is already one of the most important. The concern as a whole is highly organized, and a long article could be written about its various departments, systems and connections extending throughout the whole civilized world.



S. R. Stockvis.

The accompanying half-tone illustration shows Mr. S. R. Stockvis, director and chairman. Mr. Stockvis is the son of the head, R. S. Stockvis, the founder of the house. Although Mr. Stockvis celebrated his eightieth birthday a few months ago, he still takes the most active interest in the management of the concern's affairs. Associated with him as directors are his two sons, Felix and Hugo, and his three nephews, Charles, Louis and Theodor. The whole capital of the company is held by the six directors, and the concern, therefore, is a close corporation, its stock never being on the market.

* * *

CONSERVATION OF NATURAL RESOURCES—APRIL MEETING OF THE A. S. M. E.

A meeting of the engineering profession was held in the auditorium of the Engineering Societies building on the evening of April 14, to consider the conservation of our natural resources. The meeting was held under the auspices of the American Society of Mechanical Engineers. It was presided over by Mr. J. W. Lieb, Jr., vice-president of the society, who opened the meeting. Addresses were made by Dr. W. J. McGee, Chief of the Bureau of Soils, Washington, D. C., who spoke on the "Conservation of the Water and Woods," calling attention to the danger of stripping the country of its forests. Dr. W. F. M. Goss, dean of the College of Engineering, University of Illinois, spoke on the "Conservation of the Nation's Fuel Supply," and mentioned that the process of conservation could not successfully begin with coercion; it must begin with education. Prof. G. F. Swain, of the Massachusetts Institute of Technology, Boston, spoke on the subject of "Stream Flow, Water Power, and Navigation," thereby also bringing in the subject of preservation of the forests. This subject is highly important to all industries, as the devastation of the forests threatens some of our greatest natural resources—not the lumber resources alone; to conserve the forests means to save the water power, to prevent the erosion of the soil, and the silting of navigable rivers and harbors. The American Society of Mechanical Engineers is to be commended for the interest it has taken in this matter, and all engineers and manufacturers should realize that this subject is of more vital importance to them and to the future of the industries of the whole country than may be appreciated at first sight. The concluding address at the meeting was made by Dr. H. S. Pritchett, president of the Carnegie Foundation, who spoke of the attitude of the engineer toward the public, calling attention to the fact that engineering has become a profession which must consider not only the serving loyally of employers, but also the public interests.

* * *

AN APRIL FOOL JOKE IN A TECHNICAL JOURNAL.

The front page of a recent issue of a contemporary, whose name we forbear to mention, is decorated with a large cut of a new diving apparatus by the use of which it is expected that men will be able to work at depths of 100 feet or more without difficulty. This apparatus consists of a water-tight operating chamber, suspended from a barge and connected with it by a flexible, collapsible tube, strengthened by steel ribs to resist the pressure of the water. This tube and operating chamber are left in full communication with the open air so that the diver works under normal conditions and under atmospheric pressure. He does his work by inserting his hands in long sleeves and mittens, which project from domes in the side of the operating chamber. Lenses of strong glass are provided on all sides so that he can see clearly what he is doing.

We wonder if it occurred to the inventor of the device or to the editor of the paper in which it is illustrated that this long sleeve and mitten would be a most unhandy thing to operate. The "arm-hole" by which the sleeve is fastened to the chamber appears to have an area of at least 150 square inches. At a depth of 100 feet or thereabout the pressure on this opening would be more than 40 pounds to the square inch, or over three tons in all. This would naturally mean that the mitten and its sleeve would be blown inward with this pressure, being turned inside out, projecting into the operating chamber. We would defy the strongest "strong man" that ever drew a salary from a circus company to turn the mitten right side out again and use it in doing any useful work in the water outside.

Another interesting feature of the apparatus is that the barge from which this tube is suspended is provided with hoisting apparatus for lifting the chamber to the surface when the work undertaken has been completed. We would humbly make the suggestion that a mechanism for pushing it into the water would be more appropriate than that described for pulling it out. Would it not require a mechanism unusually powerful to force this chamber to a depth of 100 feet against the upward pressure of the water? The proper thing to do would be to fasten a block and tackle to the solid ground at the bottom, and *pull* it down. If by chance this block and tackle broke, we surmise that the chamber would be blown up through the bottom of the barge with results disastrous to everyone on board.

However, since the description of this apparatus appeared in that issue of the journal referred to nearest April 1st, it is in all probability merely a joke appropriate to the season, and the editor is doubtless enjoying a quiet laugh over the perplexity of his subscribers.

* * *

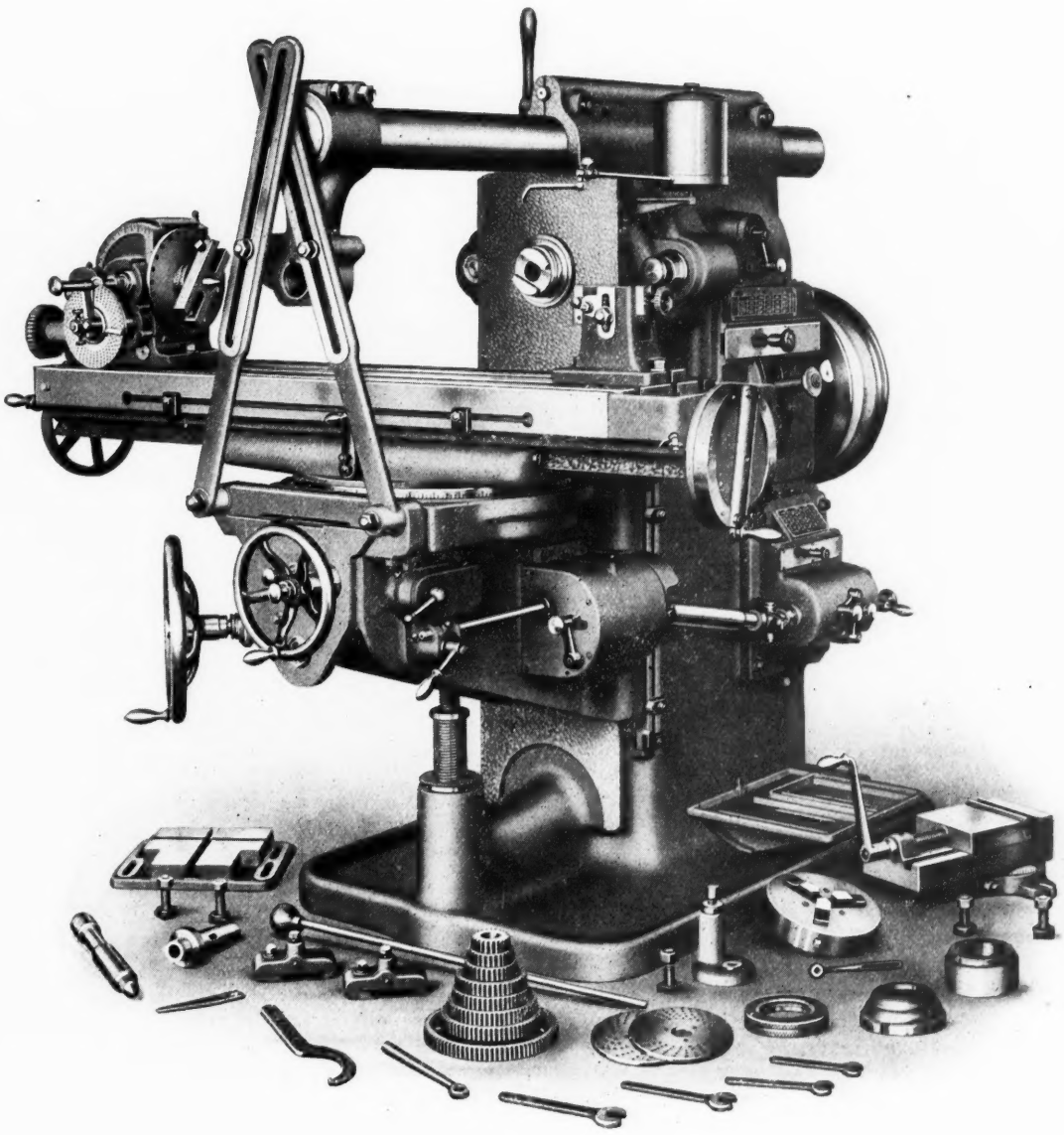
PRACTICAL IDEAS FROM AN ADVERTISING MANAGER.

The Chicago Trade Press Association and the Space Club of that city held a joint meeting on April 6th, at which Mr. C. S. Redfield, advertising manager of the Yale & Towne Mfg. Co. of New York, and Mr. J. J. Rockwell of the National Fireproofing Co. furnished the practical ideas from the standpoints of both the advertiser and the publisher.

The subject matter of the addresses was naturally more interesting to people in the advertising business than to techni-

Brown & Sharpe Mfg. Company

Providence, R. I., U. S. A.



Why the Constant Speed Drive Milling Machine?

In order that an unvariable power for any given diameter of cutter on any spindle speed can be available.

How then Can this Power be Obtained?

By means of a wide belt running at a high constant speed over a machine pulley of large diameter and a countershaft pulley of equal diameter. This gives large belt contact and high belt velocity, the *two Requisites of Power.*

Additional Advantages.

are fully described in a new booklet entitled "Why the Constant Speed Drive Milling Machine", which may be had upon application.

cal readers; but Mr. Redfield's contained a number of original remarks which are too good to bury, and we reproduce some of them here.

"Before leaving the publishers, I want to express my great appreciation of the *good* trade paper and the splendid work it does for its readers and advertisers. There is a most decided want to be filled; and it fills it. Business could not go on without it.

"The manufacturer looks to it to talk to *just* the people he wants to reach; practically no waste circulation.

"The subscriber looks to it for advice in his purchasing and selling, the arrangement of his stock, the management of his store and the keeping of his accounts; the *good* trade paper gives him all of these things.

"The merchant and the manufacturer should count it among their greatest blessings that there is to-day at least one good and indispensable trade paper in practically every field.

"The manufacturer who overlooks his trade paper, the merchant who fails to take one or more, are deliberately handicapping themselves on the road to success.

"Most men who amount to anything at all know their business, but a good advertising solicitor has got to know a lot more than his business. I don't like to use that much-abused and over-worked word 'tact,' but an advertising solicitor has got to have that too, and lots of it.

"A good man's mission in life (as things are organized) is to shed work; to be able to explain clearly to inexpensive assistants how to do things and to encourage them to do them. 'Executive ability' has never been better defined than as the talent which gets other people to do your work. The amount of work which one man can do in a day is very limited, but the amount of work which one man can accomplish in a day with the aid of organization and system is practically unlimited.

"Advertising is the spreading of news that the goods and prices are right; that the people purchasing them will be treated right; and unless they are right, and the people are treated right, advertising is worse than useless.

"The true field of the advertising manager as I see it, is not only to write good copy and see that it reaches possible purchasers (either through the trade press or circulars and booklets) but to infuse into the talk and correspondence of all those of his house who deal with the purchaser (and possible purchaser) not only the spirit of promptness but helpfulness and kindly feeling; the thought that may be summed up in the good old chestnut expression, 'We strive to please.'

"Some people think an advertising manager is one who produces catalogues and advertising copy with the right hand; selects type sizes and faces with his left, and draws pictures of the goods with his feet, when they are not used to trot over the place for facts and figures."

* * *

PERSONAL.

P. H. Biggs, formerly with Strong, Carlisle & Hammond, Cleveland, Ohio, has accepted a position with the Fellows Gear Shaper Co., of Springfield, Vt., as traveling salesman, with headquarters at Detroit, Mich.

* * *

OBITUARY.

Frank H. Chamberlin, who was at the time of his death president of The J. D. Smith Foundry Supply Co., Cleveland, Ohio, died on Friday, April 10.

Lester A. Pelton, inventor of the Pelton water wheel, died on March 15th, at Oakland, Cal., at the age of 78. Mr. Pelton was born in Vermillion, Ohio, and he came to California during the gold excitement in 1849. He there built his first wheel to develop power for mining work, and lived to see the name of his invention become almost a synonym for all impulse wheels.

* * *

NEW BOOKS AND PAMPHLETS.

REPORT OF THE COMMISSIONER OF EDUCATION, for the year ending June 30, 1906. Volume II. 1,308 6 x 9 pages. Published by the United States Government, Washington, D. C., for free distribution.

SUBJECT MATTER INDEX FOR MINING MECHANICAL AND METALLURGICAL LITERATURE, for the year 1902. Edited by M. Walton Brown. 210 pages, 6 x 9¾ inches. Published by the North of England Institute of Mining and Mechanical Engineers. Price 42s. M. Walton Brown, secretary, Newcastle-on-Tyne.

PRACTICAL EARTHWORK TABLES. By C. E. Housden. 50 pages, 5 x 7½ inches. 9 plates. Published by Longmans, Green & Co., New York. Price, 90 cents.

This little handbook contains formulas, diagrams, and tables for facilitating the reckoning of areas and volumes of embankments, cuttings, earthen dams and similar work. The methods for making calculations for this work are thoroughly explained, and a large number of illustrative examples are included.

LOCOMOTIVE BREAK-DOWNS. By Geo. L. Fowler and Wm. W. Wood. 266 pages, 4¼x6½ inches. Bound in flexible cloth. Published by Norman W. Henley & Son, 132 Nassau Street, New York. Price, $1.00.

The work is a catechism of locomotive accidents, break-downs and directions for repairing them. A large number of valuable kinks and methods to be employed are included which are not only useful on the road, but in the locomotive repair shop as well. The book was first published in 1903, and has been revised and brought up-to-date in this later edition.

PRACTICAL HYDRAULIC TABLES AND DIAGRAMS. By C. E. Housden. 105 pages, 5 x 7½ inches. 6 plates. Published by Longmans, Green & Co., New York. Price, $1.25.

The tables and diagrams in this book were originally prepared for the personal use of the author in ascertaining the sizes and costs of piping required in complicated water supply systems. They apply also to surface drains and underground sewers. By their aid, if the total length in feet of a long line of continuous pipes to provide different discharges, and the levels in feet from the point of discharge of the last pipe to the water surface of the source of supply, are known, the required sizes of the different pipes can at once be ascertained. The sizes of the drains and sewers can also be calculated from the falls in their water surfaces.

TELEPHONE CONSTRUCTION, INSTALLATION, WIRING, OPERATION, AND MAINTENANCE. By W. H. Radcliffe and H. C. Cushing, Jr. 170 pages, 4½ x 7 inches. 125 illustrations. Published by Norman W. Henley & Son, 132 Nassau St., New York. Price, $1.00.

This book is a practical reference book and guide for electricians, wiremen, engineers, contractors, architects, and others interested in standard telephone practice. It gives the principles of construction and operation of telephone instruments; approved methods of installing and wiring them; the means of protecting them from lightning and abnormal currents; their connection together for operation as series or bridging stations; and rules for their inspection and maintenance. Line wiring, and the wiring and operation of special telephone systems are also discussed.

THE HILL KINK BOOKS. Compiled by F. H. Colvin and F. A. Stanley. About 120 pages, 4x6 inches. Illustrated. Published by the Hill Publishing Co., New York. Price 50 cents each.

These little books were compiled from back issues of the *American Machinist* and include ten numbers of uniform size and appearance, bound in cloth. They are as follows: Repair Kinks; Press Tool Kinks; Toolmaking Kinks; Patternmaking Kinks; Milling Machine Kinks; Screw Thread Kinks; Screw Machine Kinks; Drawing Room Kinks; Drill Press Kinks; Jig and Fixture Kinks. Any one familiar with the large amount of valuable matter of this nature that has been published in the *American Machinist* will practically know the general character of these books. They are a compilation of the best and most generally useful of such contributions, and are illustrated with new cuts.

PROFIT MAKING IN SHOP AND FACTORY MANAGEMENT. By Chas. U. Carpenter. 146 pages, 6 x 8½ inches. Published by the *Engineering Magazine*, New York. Price, $2.00.

This book is in the main a reprint of the author's recent articles in the *Engineering Magazine*, though the original material has been revised, enlarged, rearranged and put in more convenient form for practical use and reference. The book is a unique one in that its author is the president of a large manufacturing concern (the Herring-Hall-Marvin Safe Co.), and the methods he describes are those he has applied in the reorganization of that firm, being derived from his former experiences in other responsible positions. This gives the book a practical importance which cannot be credited to many works of the same character. The book deals with the subject of reorganization, the committee system of management, reports, drafting-room systems, tool-room systems, the lessening of time on operations, high speed steels, time keeping, rate setting, wage systems, stock and cost systems, selling organization and executive organization.

REFRIGERATION. By J. Wemyss Anderson. 242 pages, 6 x 9 inches. 87 illustrations, including 4 folding plates. Published by Longmans, Green & Co., New York. Price, $2.25.

This book is an elementary treatise on the subject of refrigeration, dealing with the fundamental physical laws underlying the science, and showing the way in which these laws are utilized in the design and operation of the various forms of apparatus in commercial use. This work appears to be truly elementary in the sense that it deals with the elements of the subject, and not in the sense of being superficial. The various subjects treated are: heat and its effects; thermometers; sources of heat; energy; specific heat; latent heat; transfer of heat, radiation, conduction, convection; properties of fluids, gases, liquids, vapors; the laws of thermodynamics; Carnot's cycle; general outline of refrigerating machines, cold air, vapor, compression and absorption types; water; brine; air; liquid air; ice making; construction of cold stores and chambers; and miscellaneous uses of refrigeration.

FORMULAS IN GEARING. 183 pages, 6 x 9 inches. 21 illustrations. Published by the Brown & Sharpe Mfg. Co., Providence, R. I. Price, $1.50.

This book is so well known as to scarcely call for description on our part. This edition, the fifth, has a new treatment of the subject of differential indexing, and new tables of leads and indexing for the universal milling machine. It is printed almost entirely from new plates, and is bound in heavy board, covered with a durable cloth, suitable for constant use. Its aim is to condense as much as possible the solutions of all problems in gearing met with in ordinary practice, to the exclusion of problems dealing with the transmission of power and the strength of gearing. The mathematics employed is of a simple kind which will present no difficulty to any one familiar with ordinary algebra and the elements of trigonometry. The book is one that is indispensable to the draftsman and designer, the collection of tables, especially, being by far the most complete and most useful that has ever been brought together on the subject of gearing.

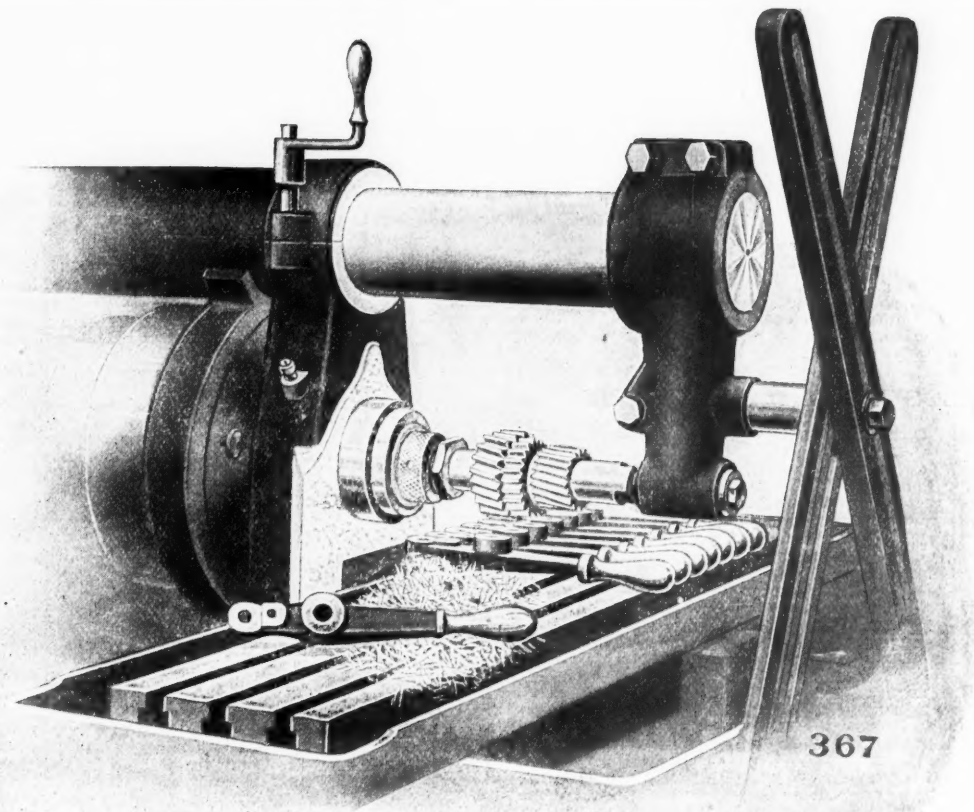
BULLETINS OF THE ENGINEERING EXPERIMENT STATION, UNIVERSITY OF ILLINOIS, Vol. II. Bulletins 9 to 17. 6 x 9 inches. Published by the University of Illinois, Urbana, Ill.

The University of Illinois has bound a limited number of the sets of their well-known bulletins, comprising the nine published in 1907. These bulletins (which are published for general distribution and are well known to mechanical engineers) treat of a wide range of subjects in a very practical way. Most of them have already been reviewed in MACHINERY. The following numbers are included in the bound volume: No. 9, An Extension of the Dewey Decimal System of Classification Applied to the Engineering Industries; No. 10, Tests of Plain and Reinforced Concrete Columns, series of 1906; No. 11, The Effect of Scale on the Transmission of Heat Through Locomotive Boiler Tubes; No. 12, Tests of Reinforced Concrete T-Beams, series of 1906; No. 13, An Extension of the Dewey Decimal System of Classification Applied to Architecture and Building; No. 14, Tests of Reinforced Concrete Beams, series of 1906; No. 15, How to Burn Illinois Coal without Smoke; No. 16, A Study of Roof Trusses; No. 17, The Weathering of Coal.

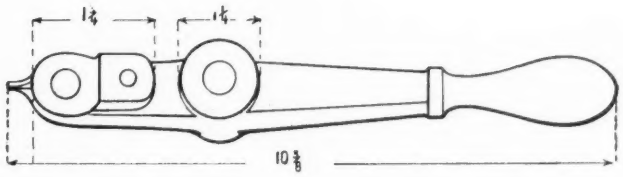
HYDRAULIC ENGINEERING. By Gardner D. Hiscox, M.E. 315 pages, 6½ x 9½ inches. 305 illustrations. Published by Norman W. Henley & Son, 132 Nassau St., New York. Price, $4.00.

This book treats of a wide range of subjects relating to hydraulics, beginning with a historical study of the question, showing the ancient

100 Pieces in 2 Hours



The No. 2 Plain Cincinnati Miller



fitted with a "string jig" and cutters 3½", 3⅛" and 2¾" diameter, running 56 r. p. m., feeding .033", mills these malleable iron castings at a table travel of 1.8" per minute. The cut is 1¼" long, 3" wide, and about 1-16" deep. It finishes 100 of these pieces in 2 hours. That means an *average time of 1.2 minutes each*, including chucking. *Let us submit estimates on your milling work.*

WE ARE MILLING SPECIALISTS

THE CINCINNATI MILLING MACHINE CO.

CINCINNATI, OHIO, U. S. A.

European Agents—Schuchardt & Schutte, Berlin, Vienna, Copenhagen, Budapest, St. Petersburg, Stockholm. Alfred H. Schutte, Cologne, Brussels, Liege, Milan, Paris, Turin, Barcelona and Bilbao. Charles Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow.
Canada Agent—H. W. Petrie, Limited, Toronto, Montreal and Vancouver.

beginnings of the modern apparatus the book describes. The scope of the book will be appreciated from the table of contents herewith given: Historical sketch from the earliest times; hydraulics, properties of water; measurement of flow of streams; flow from sub-surface orifices and nozzles; flow of water in pipes; siphons of various kinds; dams and great storage reservoirs; city and town water supply; wells and their reinforcement; air lift method of raising water; artesian wells; irrigation for arid districts; water-power and water-wheels; pumps and pumping machinery; reciprocating pumps; hydraulic power transmission; hydraulic mining; canals, ditches, conduits and pipe lines; marine hydraulics; tidal and sea wave power. The author's treatment of these subjects is such that all but the simplest explanations have been avoided, so that any one interested can readily master the contents of the book.

ENGINEERING INDEX ANNUAL FOR 1907. 435 pages, 7 x 9½ inches. Published by the *Engineering Magazine*, New York. Price, $2.00.

This volume is compiled from the twelve issues of the *Engineering Index* for the year 1907, published in the *Engineering Magazine*. This index is, for American users at least, by far the most useful permanent record of technical periodical literature. The range of subjects is complete, so far as concerns civil, electrical, marine and naval, mechanical, mining and metallurgical, and railway engineering. This is the sixth volume of the index published since the work was first undertaken, and the second since it assumed the annual form. The complete series forms a guide to the technical literature of the past twenty-four years. In this last volume the "classified" system of arrangement has been followed, instead of the strict alphabetical order of the earlier volumes. The serial classification is followed only in the main divisions and subdivisions; after these two steps have been taken the final arrangement for each section becomes strictly alphabetical. This arrangement collates for each specialist the entire current literature on his subject, and assembles it in a small space, where it may be readily found and completely explored. This index will be found invaluable to any one who has occasion to search the files of the technical press.

CATALOGUES AND CIRCULARS.

CLEVELAND TWIST DRILL CO. Circular of Paradox Adjustable Reamers.

WESTERN ELECTRIC CO., Hawthorne, Ill. Bulletin No. 5910-5 on Power Equipment for Printing Offices.

LODGE & SHIPLEY MACHINE TOOL CO., Cincinnati, O. Catalogue S on engine lathes, describing and illustrating the various parts of the lathe in detail, and giving specifications for the various types.

S. W. CARD MFG. CO., Mansfield, Mass. Catalogue No. 25, giving dimensions and specifications for the various taps, dies, screw plates, die stocks, tap wrenches, etc., manufactured by the company.

GARVIN MACHINE CO., Spring and Varick Sts., New York. Catalogue, edition C, printed in English, French, and German, containing information about milling machines, knee type, universal, plain, constant drive, vertical, hand and motor drive, and die slotter and cutter grinder.

HYATT ROLLER BEARING CO., Newark, N. J. Bulletin No. 31, entitled "Stock Sizes Hyatt Standard Bushings." This company has standardized its products, and offers the trade over 300 sizes of standard Hyatt bearings, each provided for different conditions of speed and load.

CROCKER-WHEELER CO., Ampere, N. J. Bulletins Nos. 95, 97, 98, 99, and 100, on belt type, alternating current generators, direct current switchboard panels, form L machines, Crocker-Wheeler motors in the Bethlehem Rail and Structural Mills, and form I machines, respectively.

BEAUDRY & CO., INC., 141 Milk St., Boston, Mass. Booklet descriptive of the operation and construction of the Beaudry Champion power hammer. This hammer is built in sizes from 50 to 500 pounds weight of ram, and is adapted to almost every kind of forging, from the smallest knife blade to a 6-inch bar of steel or iron.

OESTERLEIN MACHINE CO., 2846-2850 Spring Grove Ave., Cincinnati, O. Circular giving specifications for universal cutter and tool grinder No. 2. A number of half-tone views illustrate the method of setting up the machine for various operations, as centering work and tooth rest with centering gage; sharpening side milling cutters without taking cutter from arbor; sharpening end mill; grinding face of shoulder, etc.

WILLIAM H. BRISTOL, 45 Vesey St., New York City. Catalogue No. 17, of electric pyrometers. This catalogue shows both indicating and recording pyrometers of both switchboard and portable models, and also illustrates the methods of applying the Bristol electric pyrometers to different kinds of furnaces, and lead baths, and to pipes, mains or tanks, containing superheated steam, liquids or gases under pressure.

DIAMOND MACHINE CO., Providence, R. I. Catalogue of improved wet tool grinders, both belt and motor driven. A number of different sizes and designs are illustrated and described, and essential dimensions given. Another catalogue from the same company treats of the American grinding attachments, and the American center grinders, manufactured by the company, and shows several examples of the application of these tools to a number of grinding operations.

AMERICAN EMERY WHEEL WORKS, Providence, R. I. Catalogue of emery and corundum wheels and specialties, containing the most complete list of illustrations of special wheels of any catalogue previously issued by the company. Special attention is called to the *facsimile* of testing sheet, shown on page 12, article on "Testing for Grade," page 14, rules for the selection of wheels for automatic grinding and hand grinding, pages 20 and 21, and table showing the numbers and grades usually furnished for a variety of purposes.

HAMILTON MACHINE TOOL CO., Hamilton, O. Bulletins Nos. 1 to 60, inclusive, of lathes, planers, shapers, and upright and radial drills. Bulletins Nos. 1 to 20, inclusive, treat of Hamilton lathes from 14- to 36-inch capacity; bulletins Nos. 21 to 23 treat of lathe attachments; Nos. 24 to 39 treat of upright drills; Nos. 40 and 41, of 42- and 48-inch lathes; Nos. 42 to 46, of geared and motor-driven, and special lathes. The company's line of planers are illustrated and described in Bulletins Nos. 47 to 55, inclusive, and Nos. 56 to 59 show the Hamilton shapers. Bulletin No. 60 describes the Hamilton horizontal drilling, boring, and milling machine.

BULLARD MACHINE TOOL CO., Bridgeport, Conn. Catalogue E14, entitled "Boring Mill Accessories." This catalogue illustrates and describes an interesting line of tools for boring mills, vertical and horizontal turret lathes, etc. Among the tools shown are boring bars for use in turret machines, thread cutting bars, the chasing bars for pipe threads, combination boring and reaming bars, combination boring, turning, and facing bars, adjustable reamers, floating reamer sockets, core drills, reamer grinders, cutter grinders, tool-holders and standard tools for boring mill work, chucks, etc. Many of the tools are of novel and interesting design, and differ decidedly from the type of home-made boring mill tools often seen around the shops.

HEALD MACHINE CO., Worcester, Mass. Pamphlet on the Heald internal grinder, an improved form of internal grinding machine, describing its details of construction, and pointing out the advantages to be obtained by using this machine. The three essentials for rapid and accurate work have been secured, *viz.*, a massive and rigid machine which will resist vibration and give the wheel the ability to cut freely and smoothly; five different speeds of rotation for the work, covering different sizes of holes and material to be ground; three different speeds of table travel for each of the five work speeds. Special attention has been paid to the matter of rigidity in the designing of this machine.

FOOTE BROS. GEAR & MACHINE CO., 24-30 South Clinton St., Chicago, Ill. Catalogue of gears and special machinery. The catalogue is not only a list of products of the company, but contains also considerable information on gears and gearing. All the common tables of gear wheels are included, and besides these, tables are given for the horse-power transmitted by gear teeth of various pitches and width of face, extensive tables for conversion of gears having circular pitch to approximate diametral pitches, full size lay-out of gear teeth of various pitches, etc. The main part of the catalogue gives a price-list of spur gears, bevel gears, worms, worm-wheels, spiral gears and sprockets, together with a large amount of valuable information and tables, interspersed at proper places. The James & Foote Universal Milling Machine, with attachments, is also included.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin No. 4570, describing and illustrating the General Electric tungsten lamp for 100- to 125-volt circuits. The lamp is made in 40, 60, and 100 watts, and has a life of approximately 800 hours when used on either alternating or direct current. Some of the illustrations show the tungsten incandescent units combined with standard Holophanes, which can be used to excellent advantage in this manner. Bulletin No. 4573 describes the graded shunt resistance multigap lightning arresters, and contains detailed descriptions of low-voltage arresters, static dischargers, constant current horn arresters, disconnecting switches, choke coils, and the well-known type M, form D-2, direct-current arrester for voltages up to 6,000. Tables of general data regarding the apparatus, connection and dimension diagrams, etc., are included.

MANUFACTURERS NOTES.

LUCAS MACHINE TOOL CO., Cleveland, O., manufacturer of the Precision boring, drilling, and milling machine, has just completed a large office building and a 50 x 140-foot addition to its shop.

WELLS BROS. CO., Greenfield, Mass., has moved into a new factory which will be thoroughly systematized for the manufacture of taps, dies and screw cutting tools, and machinery in general.

AMERICAN LOCOMOTIVE CO. on and after April 24, will have its general offices located in the Cortlandt Building, 30 Church St., New York, moving there from its present location at 111 Broadway.

NORTHERN ENGINEERING WORKS, 26 Chene St., Detroit, Mich., has recently completed a 15-ton 48-foot span Northern traveling crane for the Mammoth Copper Mining Co., of Kennett, Cal.

GENERAL ELECTRIC CO., Schenectady, New York, announces that the total capacity of Curtis steam turbines, sold up to December 31, 1907, was 1,556,000 B.H.P. This is a strong indication of the advance of the steam turbine generating unit.

PACIFIC TOOL & SUPPLY CO., Chas. Stallman, manager, San Francisco, Cal., announces that the firm has been re-established in a new building, at the northwest corner of Mission and Fremont Streets, in what is stated to be a Class A, fire- and earthquake-proof building, of reinforced concrete.

G. M. YOST MFG. CO., Mechanicsburg, Pa., has just erected and equipped a large new plant at Meadville, Crawford Co., Pa. The main office of the company is now at that place, and all future correspondence should be addressed to Meadville, Pa.

D. O. JAMES, South Canal St., Chicago, Ill., manufacturer of cut gears, has erected a large plant at 351-353 West Monroe St., Chicago, which will greatly improve his facilities for handling his rapidly increasing business.

NORTHERN ENGINEERING WORKS, 26 Chene St., Detroit, Mich., announces the following recent shipments of traveling cranes: Bodeman Light, Heat & Power Co., Johnstown, Pa., 12 ton; Mineral Wells Electric Co., 5 ton; Northern Pacific Railway, Brainard plant, 10 ton.

WESTINGHOUSE ELECTRIC AND MFG. CO., of Pittsburg, Pa., has removed the executive New York offices from 111 Broadway, and the New York sales offices and export offices from 11 Pine St., to the City Investing Building, 165 Broadway, New York.

WALTER H. FOSTER CO., selling agent for Gisholt Machine Co., Landis Tool Co., Potter & Johnston Machine Co., Ingersoll Milling Machine Co., Landis Machine Co., and Lassiter special machines, removed on April 25 to 1479 Fulton Building, Hudson Terminal, 50 Church St., New York.

PITTSBURG AUTOMATIC VISE AND TOOL CO. has made arrangements with Mr. R. C. McCully, of St. Louis, Mo., to act as the company's representative in that locality. He will have an office and warerooms on Olive St., where a supply of vises will be carried in stock to better care for the wants of local customers.

ELECTRIC WELDING PRODUCTS CO. is the new name which has been given to the concern formerly known as the Cleveland Cap Screw Co. of Cleveland, Ohio. The new name more fully describes the work of the firm, which includes all kinds of electrical welding, and is not confined to the making of cap screws alone.

CURTIS & CURTIS CO., 8 Garden St., Bridgeport, Conn., reports encouraging signs of improvement in its business. Unusually large shipments have recently been made from the works on export delivery, which includes six machines to Russia, five to Australia, five to England, four to Kobe, Japan, four to Yokohama, Japan, three to Mexico, and several to South America and British Columbia.

SMITH & WATSON IRON WORKS, Portland, Ore., is preparing plans for a new machine shop of brick construction, 110 x 200 feet. On account of this, the company will be in the market for a 20-ton traveling crane, and machines for the manufacture of sawmill machinery and transmissions, and would appreciate catalogues from manufacturers of this class of machines.

CROCKER-WHEELER CO., Ampere, N. J., has moved the New York office to the Cortlandt Building, Hudson Terminal, 32 Cortlandt St. This building is a 22-story building, one of the largest in the city, and the machinery headquarters in New York. The new location is of special convenience, as it brings the New York office of the company closer in touch than ever with the works and the main office at Ampere, N. J.

WESTINGHOUSE AIR BRAKE CO., Wilmerding, Pa., has completed the development of an entirely new type of brake for freight, passenger, and locomotive service, within the past three years, which has proved so successful that many of the larger railroads have already adopted it and made it standard in all their rolling stock. This new brake can stop a freight train of one hundred cars as quickly as the old form of brake would stop a fifty-car train.

GENERAL PNEUMATIC TOOL CO., of Montour Falls, N. Y., has removed the New York office from the Singer Building, to the Fulton Building, Hudson Terminal, New York City. On May 18 the name of this company will be changed to Shepard Electric Crane and Hoist Co. The change of name has been made to harmonize the name with the product of the company, which consists of a line of more than 200 distinct types and sizes of electric hoists, ranging in capacities from 1/2 to 20 tons, for practically every kind of service.

PERRY TIME STAMP CO., 23-25 South Jefferson St., Chicago, Ill., has been reorganized under the name of The Stromberg Electric Manufacturing Co., A. Stromberg being president, W. Clyde Jones,

Showing case open

A MACHINISTS' PORTABLE TOOL CASE

(Patent Applied for)

This is the only practical portable tool case on the market. The drawers are so arranged that every available inch can be utilized, and the tools so distributed that each one can quickly and easily be picked out and without first handling over a number of other tools which have hurriedly been placed on top of the one wanted.

With the exception of the bottoms and sides of drawers, it is made throughout of thoroughly kiln-dried solid (not veneered) oak, which will not warp nor twist, and very carefully and handsomely polished and finished; the corners are dovetailed and the workmanship is of the very best. The trimmings are of polished brass; has a brass spring-lock with 2 flat steel keys, and a comfortable leather handle for convenience in carrying.

Showing case closed and locked.

The **outside** measurements of the case when closed are: 15⅝ in. long, 8 in. deep, 10¾ in. high. The **inside** dimensions of the eight drawers are as follows:

First	6⅜	in. long,	6	in. deep,	¾	in. high
Second	6⅜	"	6	"	2 5/16	"
Third	6⅜	"	6	"	¾	"
Fourth	6⅜	"	6	"	1 1/16	"
Fifth	6⅜	"	6	"	1 1/16	"
Sixth	14	"	6	"	½	"
Seventh	14	"	6	"	13/16	"
Eighth	14	"	6	"	3½	"

The drawers are all felt-lined, run on hardwood slides, and have polished brass knobs.

Machinists will find the little mirror which is placed on the inside of the case a very handy and convenient addition. The weight is 16 pounds—packed for shipment approximately 30 pounds.

Price, $12.00 each, net, F.O.B. New York.

We can also furnish this case in mahogany finish at the same price.

In ordering please mention this advertisement.

HAMMACHER, SCHLEMMER & CO.

HARDWARE, TOOLS AND SUPPLIES

NEW YORK SINCE 1848

4th Avenue and 13th Street **(Block South of Union Square)**

CONTENTS FOR MAY.

A 2,000 H. P. Gas Engine Blowing Unit..... 581
The Design of Springs for Gas Engine Valves. F. E. Whittlesey 585
Pole Piece Design for Dynamos. E. A. Lof..... 586
Comparative Value of Alcohol and Gasoline as Engine Fuels 588
Gear-Cutting Machinery—5. Ralph E. Flanders..... 589
Notes from the New Shops of the Heald Machine Co.. 597
Drop and Stamped Forgings. Joseph Horner..... 600
The Setting Up and Operation of the Potter & Johnston Automatic Chucking Machine—2..... 605
Monnet & Moyne Machine for Bending Tubing..... 609
How Billy Came to Use Twist Drills..... 610
Items of Mechanical Interest..... 611
Editorial 612
The Quebec Bridge Disaster..... 615
Die Sinking and Engraving Machine..... 615
The Manufacture of Machine Tools in Germany..... 616
Maximum Stresses—2. John S. Myers..... 617
Jigs and Fixtures—2. Einar N. Morin..... 621
Machine Shop Practice..... 623
Two-Jawed Lathe Chucks. Ethan Viall..... 625
To Make Accurate Arbors. Foster Hillix..... 626
Apparatus for Measuring the Slip of Belts. Moritz Kroll 627
Direct Fractional-Reading Micrometer. Charles A. Kelley 628
The Confidences of a Workman. Mars..... 628
Expansion Boring-Bars. B. M. Weller..... 629
Making Piston Rings. Y. Ziegler..... 629
Technical Education for Machinists. F. Walsleben... 630
Simple Cost System for Small Shops. Chas. Roels..... 631
Ball Grinding Fixture. W. A. Sawyer..... 631
Device for Oiling Loose Pulleys Which are Inaccessible for Ordinary Oiling Devices. Moritz Kroll..... 632
Puzzling Arithmetical Expressions. D. W. James..... 632
Locking Device for Jigs. Tool Designer..... 632
Shop Kinks 633
How and Why..... 634
New Machinery and Tools..... 636
An American Mechanic in Europe—2. Oskar Kylin..... 660

vice-president; H. A. Jones, secretary and general manager; A. Carlson, treasurer, and C. M. Crook, superintendent. George E. Dixon and C. S. Perry are also directors. This firm will shortly place on the market a new electric time stamp, run by a master clock. The manufacture of the hand stamp, which is in use in many shops in this country and abroad, will also be continued.

Quincy, Manchester, Sargent Co., Plainfield, N. J., has decided to discontinue the manufacture of the line of pneumatic compression riveters which the company acquired at the time of purchasing the Pedrick & Ayer business, and has disposed of this entire line to the Hanna Engineering Co., of Chicago, Ill., which company will improve the line and will be in a position to furnish repair parts for such riveters as have been sold in the past. The reason for the discontinuance of this manufacture is that the Quincy, Manchester, Sargent Co. wishes to devote its entire attention to metal-sawing machines, cranes and hoists, and car steps.

Hess-Bright Mfg. Co., Philadelphia, Pa. Up to five years ago the Mont Ventoux, near Avignon, France, was the "Mountain Despair" of automobilists. It speaks much for the improvements since then that it is now only a strain to try the mettle of cars. The hill is 14.32 miles long, stony, dusty, with sharp turns beside yawning precipices, unprotected by wall or barrier and grades of 8 to 20 per cent. In September of this year Rougier took it in his Grand Prix Dietrich in 19 minutes 59 2/5 seconds, averaging 41.2 miles per hour. He came within 17 seconds of the record established by Fiat two years before. Both years the winning cars were equipped with "Hess-Bright DWF" ball bearings.

Cutler-Hammer Mfg. Co., Milwaukee, Wis., has been awarded the contract for the electric turret-turning gear of the U. S. S. *Delaware*, now under construction at Newport News. This company designed and built the electric turret-turning gear installed in the port, after-turret of the *Indiana*, the crew of which holds the world's record for marksmanship—ten shots in two and a half minutes, all hits. Every modern war vessel is equipped with a complete electrical plant, the specifications of some of the newer battleships calling for generators having a combined output of 800 kilowatts. In addition to illumination, wireless telegraphy and interior signal systems, electricity is used on shipboard in connection with the refrigerating plant, ventilating fans, forced-draft blowers, and for operating ammunition hoists, boat cranes, deck winches, etc.

S. Obermayer Co. has opened a warehouse at 1604 North Broadway, St. Louis, with Mr. C. M. Barker, one of the best-known foundry supply men in the West, in charge. Mr. Barker, as representative of the S. Obermayer Co., has occupied offices in the Roe Building for a number of years, and the company, on account of the ever-increasing demand for its goods, has found it necessary to carry a large stock of foundry facings and supplies to supply the immediate needs of the foundries in and adjacent to St. Louis at a more accessible location. The company now has factories and warehouses located as follows: Cincinnati, 647 Evans St.; Chicago, 18th and Rockwell Sts.; Pittsburg, 35th and Charlotte Sts.; Philadelphia, 2516 Aspen St.; St. Louis, 1604 North Broadway; Cleveland, 6305 Euclid Ave.; Denver, 305 Appel Building and 620 19th St.; Kansas City, Massachusetts Building; Milwaukee, 696 Prospect Ave.; Troy, Campbell's Highway and Thomas St.

COMING EVENTS.

April 1 to June 1.—Exposition of Safety Devices under the auspices of the American Museum of Safety Devices and Social Hygeine, 231 W. 39th St., New York. Dr. W. H. Tolman, secretary.

May 13 to 15.—Joint Annual Convention of the American Supply and Machinery Manufacturers' Association, the National Supply and Machinery Dealers' Association and the Southern Supply and Machinery Dealers' Association, at Richmond, Va. Secretary Wm. H. Taft will speak at a joint open meeting of the three associations on Wednesday afternoon, May 13. Further information can be obtained from the secretary of the American Supply and Machinery Manufacturers' Association, Mr. F. D. Mitchell, 309 Broadway, N. Y.

May 18 to 20.—Annual Convention, National Manufacturers' Association, New York. Headquarters, Hotel Astor.

May 19 to 20.—National Machine Tool Builders' Association Convention, Atlantic City, N. J. Headquarters, Hotel Chalfonte.

June 8.—International Congress for Life-Saving Apparatus, in Frankfort a. Main, Germany, commencing June 8. Detailed information regarding this congress may be obtained from Dr. Wm. H. Tolman, director of the American Museum of Safety Devices, 231 W. 39th St., New York, or by addressing the Bureau des Internationalen Kongresses für Rettingswesen (Herrn Dr. Düms) Nikolaikirchhof 2, Leipzig, Germany.

June 9 to 11.—Convention, American Foundrymen's Association, at Toronto, Canada. Richard Moldenke, Watchung, N. J., secretary.

June 9.—Convention, Air Brake Association, St. Paul, Minn. F. M. Nellis, 53 State St., Boston, Mass., secretary.

June 17 to 19.—Master Car Builders' Association Convention, Atlantic City, N. J. Jos. W. Taylor, 390 Old Colony Building, Chicago, Ill., secretary.

June 22 to 24.—American Railway Master Mechanics' Association Convention, Atlantic City, N. J. Jos. W. Taylor, 390 Old Colony Building, Chicago, Ill., secretary.

June 23 to 26.—American Society of Mechanical Engineers, Annual Convention, Detroit, Mich. C. W. Rice, 29 W. 39th St., New York City, secretary.

June 23 to 27.—American Society for Testing Materials, Annual Meeting, Atlantic City, N. J. Edgar Marburg, University of Pennsylvania, Philadelphia, Pa., secretary.

MISCELLANEOUS.

Advertisements in this column, 25 cents a line, ten words to a line. The money should be sent with the order. Answers addressed to our care will be forwarded. Original letters of recommendation should not be enclosed to unknown correspondents.

AN ENGLISH COMPANY having a plant suitable for the manufacture of small patented specialties in brass and steel, are prepared to negotiate for the manufacture of American patents—consequent upon the new patent laws now enforced in the British Isles. Works situated between Manchester and Liverpool. Address JOHN MACNAB, Engineer, Hyde, Cheshire, England.

DETAIL DRAWINGS, TRACINGS, ETC., MADE AT REASONABLE PRICES. Address Box 174, care Machinery, 49-55 Lafayette Street, New York.

DRAFTSMEN AND MACHINISTS.—American and foreign patents secured promptly; reliable researches made on patentability or validity; twenty years' practice; registered; responsible references. EDWIN GUTHRIE, Corcoran Building, Washington, D. C.

FILE OF "MACHINERY" FOR SALE. Complete file of Machinery since 1898. Address "T. L." care of The Industrial Press, 49-55 Lafayette St., New York City.

HUGO VOGEL, 112 S. Clark St., Room 823. 'Phone, Maine 3777, Chicago, Ill. Machine Designs of any kind.

I MAKE DRAWINGS, TRACINGS, BLUEPRINTS, etc. D. TAPPAN, Watervliet, N. Y.

MAKE A TEST INDICATOR WORTH $50.00. Send 10 cents for blueprint and particulars. DE WITT TAPPAN, Watervliet, N. Y.

PATENTS.—H. W. T. Jenner, patent attorney and mechanical expert, 608 F Street, Washington, D. C. Established 1883. I make an examination free of charge, and report if a patent can be had and exactly how much it will cost. Send for circular. Member of Patent Law Association.

POSITION WANTED as Mechanical Designer and Draftsman, or Assistant Superintendent. Seven years shop and eight years drafting experience. Best of references. Address Box 173, care Machinery, 49 Lafayette St., New York.

RELIABLE AND ESTABLISHED MANUFACTURERS' AGENTS desired to handle the Riblet Transverse Current Feed Water Heater. Exclusive territory and liberal commission to energetic parties. Write: THE RIBLET COMPANY, Erie, Pa.

SHOP ARITHMETIC FOR THE MACHINIST, an entirely new publication issued by Machinery, is fully described in the advertising beginning on page 147 of this number. The price is 25 cents, and there is nothing else at any price that meets the requirements as this book does.

TAPS.—Wanted, automatic machinery of modern design for manufacturing taps. Would buy patents of a perfect machine already running. Write to HEINRICH DREYER, Importer of American Machinery, Berlin, C. Kaiser Wilhelmstrasse 1.

USE OF FORMULAS and of Tables of Sines and Tangents, without a knowledge of Algebra or Trigonometry is made easy to you by SHOP ARITHMETIC FOR THE MACHINIST, which is No. 18 in Machinery's Reference Series fully described in advertisement page 147 to 154, this number.

WANTED.—Agents, machinists, toolmakers, draftsmen, attention! New and revised edition Saunders' "Hand Book of Practical Mechanics" now ready. Machinists say "Can't get along without it." Best in the land. Shop kinks, secrets from note books, rules, formulas, most complete reference tables, tough problems figured by simple arithmetic. Valuable information condensed in pocket size. Price postpaid $1.00 cloth; $1.25 leather with flap. Agents make big profits. Send for list of books. E. H. SAUNDERS, 216 Purchase St., Boston, Mass.

WANTED.—Agents in every shop to sell Calipers. Liberal pay. Address E. G. SMITH CO., Columbia, Pa.

WANTED.—A-1 FACTORY MANAGER. Must have a good knowledge of sheet metal business. We require a man with executive ability—one capable of organizing and handling men to the best advantage. Must be practical and up-to-date. Plant is located in Illinois. Give full account of past experience. Correspondence confidential. Address Box 171, care Machinery, 49 Lafayette St., New York.

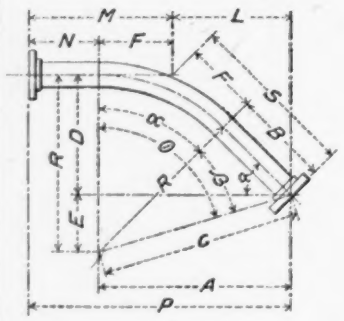
WANTED.—Position as Foreman, Master Mechanic, or Superintendent; have 25 years experience in manufacturing lines, light and heavy mill machinery, water works, engines and pumps and gas engine building; have good mechanical education and can handle men to good advantage. Best of references furnished. Can go East or West. Box 172, care Machinery, 49-55 Lafayette St., New York.

COPYRIGHT, 1908, BY THE INDUSTRIAL PRESS, NEW YORK

Diagrams and Tables for the Articles in this number entitled "Pipe Bends" ar

I.—FORMULAS FOR PIPE BENDS.

Angle Bends. Given dimensions P, N, D, R.



$A = P - N$; $E = R - D$

$C = \sqrt{E^2 + A^2}$ or $C^2 = A^2 + E^2$

$B = \sqrt{C^2 - R^2}$

Cot. $\theta = \frac{E}{A}$ or Tang. $\theta = \frac{A}{E}$

Cot. $\beta = \frac{R}{B}$ or Tang. $= \frac{B}{R}$

Angle $\alpha = \theta - \beta$

$F = R \times$ Tang. $\frac{1}{2}\alpha$

$M = N + F$; $L = A - F$

Given dimensions P, N, A, R, B.

$C^2 = B^2 + R^2$; $E = \sqrt{C^2 - A^2}$; $D = R - E$.

Tang. $\theta = \frac{A}{E}$; Tang. $\beta = \frac{B}{R}$; $\alpha = \theta - \beta$; $F = R \times$ Tang. $\frac{1}{2}\alpha$;

$M = N + F$; $S = F + B$; $L = A - F$.

Given dimensions P, N, A, α, and R.

$F = R \times$ Tang. $\frac{1}{2}\alpha$. $L = A - F$. Tang. $\alpha = \frac{D}{L}$. $D =$ Tang. $\alpha \times L$.

$S = \sqrt{L^2 + D^2}$ or $S = \frac{D}{\text{Sine } \alpha}$. $B = S - F$.

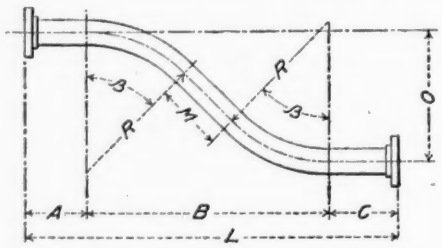
$M = N + F$. Dimensions A, θ, C, E not required.

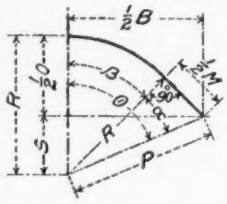
Given dimensions P, N, A, D, and α; to find R, B, and F.

$L = \frac{D}{\text{Tang. } \alpha}$. $F = A - L$. $R = \frac{F}{\text{Tang. } \frac{1}{2}\alpha}$. $B = \sqrt{A^2 - 2RD + D^2}$.

Standard radius R = 6 pipe diameters.
Minimum radius R = 3 pipe diameters.
N, or B, should not be less than 1 pipe diameter.
When R = 3 diameters, use extra heavy pipe.
When R = over 3 diameters, use full weight pipe.

Offset Bend with Straight Between Arcs.





D = Diameter of pipe.
Standard radius R = 6D.
Minimum radius R = 3D.

Given dimensions L, R, O, A, M.

To find β, B, and C.

$S = R - \frac{1}{2}O$ $\quad P = \sqrt{R^2 + (\frac{1}{2}M)^2}$

Tang. $\alpha = \frac{\frac{1}{2}M}{R}$. $\quad \frac{1}{2}B = \sqrt{P^2 - S^2}$

Tang. $\theta = \frac{\frac{1}{2}B}{S}$. $\quad$ Angle $\beta = \theta - \alpha$

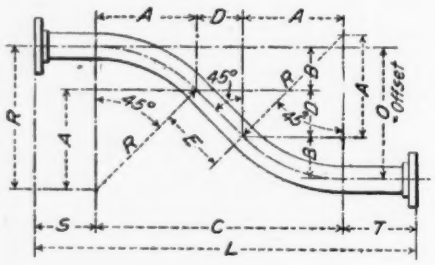
$C = L - (A + B)$

M, is usually made 12".
A or C should never be made less than D when good bends with tight flanges are required.
When R = 3D, use extra heavy pipe.
When R = over 3D, use full weight pipe.

Contributed by Wm. F. Fischer.

II.—FORMULAS FOR PIPE BENDS.

45-Degree Offsets.
Given offset O, radius R, length L and S.

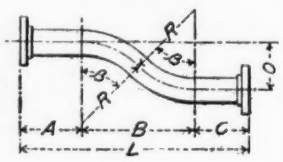


$A = R \times 0.707$
$B = R - A$
$D = O - 2B$
$E = D \times 1.414$
$C = 2A + D$
$T = L - (C + S)$

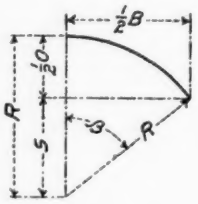
Length of each arc on center line equals 0.7854 x rad. R.

Note:—
Standard radius R = 6 x diam. of pipe.
Minimum radius R = 3 x diam. of pipe
S, or T, should not be less than 1 x diam. of pipe.
When R = 3 x diam. of pipe, use extra heavy pipe.
When R is over 3 x diam. of pipe, use full weight pipe.
When possible, keep S, or T, equal to at least 1½ x diam. of pipe or more, when screwed flanges are used.

Offset Bend.
No straight between arcs.



D = Diameter of pipe
Standard radius R = 6D.
Minimum radius R = 3D.



Dimensions given L, O, R, A.
To find β, B, C.

$S = R - \frac{1}{2}O$

$\frac{1}{2}B = \sqrt{R^2 - S^2}$. $\quad B = 2 \times \frac{1}{2}B$.

Tangent $\beta = \frac{\frac{1}{2}B}{S}$.

$C = L - (A + B)$.

When it is necessary to keep L as short as possible, make A and C each equal to one diam. of pipe, (This should be the limit for good bends), and make radius R = 3D.

To find dimensions L, B, and angle β:

$S = R - \frac{1}{2}O$. $\quad \frac{1}{2}B = \sqrt{R^2 - S^2}$ $\quad B = 2 \times \frac{1}{2}B$.

Tang. $\beta = \frac{\frac{1}{2}B}{S}$ $\quad L = A + B + C$.

When R = 3D, use extra heavy pipe.
When R = over 3D, use full weight pipe.

Contributed by Wm. F. Fischer.

I.—SPEED, HORSE-POWER, AND CAPACITY OF CENTRIFUGAL FANS.

Contributed by Charles L. Hubbard.

Height of Casing in Inches	Diameter of Fan in Feet	Speed, horse-power, and capacity in cubic feet per minute for centrifugal fans discharging into free air. *							
			¼ oz.	⅜ oz.	½ oz.	⅝ oz.	¾ oz.	⅞ oz.	1 oz.
40	2	R. P. M.	493	605	698	780	854	923	980
		H. P.	0.4	0.8	1.2	1.7	2.5	2.9	3.5
		Cu. Ft.	2585	3165	3653	4084	4472	4829	5161
50	2½	R. P. M.	395	484	558	624	684	738	788
		H. P.	0.7	1.2	1.9	2.6	3.8	4.3	5.2
		Cu. Ft.	3877	4747	5480	6126	6708	7244	7741
60	3	R. P. M.	328	403	465	531	570	615	657
		H. P.	1.0	1.9	2.8	3.8	5.0	6.4	7.9
		Cu. Ft.	5690	6960	7380	8980	9840	10600	11350
70	3½	R. P. M.	282	345	398	446	488	520	562
		H. P.	1.5	2.5	3.8	5.4	7.0	8.8	10.8
		Cu. Ft.	7750	9490	10950	12250	13400	14500	15500
80	4	R. P. M.	247	302	349	390	427	460	493
		H. P.	1.8	3.3	5.0	6.9	9.1	11.5	14.0
		Cu. Ft.	10350	12650	14600	16350	17900	19300	20650
90	4½	R. P. M.	219	268	309	346	379	410	438
		H. P.	2.3	4.0	6.3	8.8	11.5	14.5	17.8
		Cu. Ft.	12950	15850	18250	20400	22350	24150	25800

* For schools, churches, etc., reduce capacity and horse-power 20 per cent for given speed. For shops and factories reduce capacity and horse-power 40 per cent for given speed.

II.—SPEED, HORSE-POWER, AND CAPACITY OF CENTRIFUGAL FANS.

Contributed by Charles L. Hubbard.

Height of Casing in Inches	Diameter of Fan in Feet	Speed, horse-power, and capacity in cubic feet per minute for centrifugal fans discharging into free air. *							
			¼ oz.	⅜ oz.	½ oz.	⅝ oz.	¾ oz.	⅞ oz.	1 oz.
100	5	R. P. M.	196	242	278	312	342	369	394
		H. P.	2.8	5.0	7.8	10.3	14.3	17.9	21.9
		Cu. Ft.	16050	19600	22650	25500	27750	29950	32000
120	6	R. P. M.	164	201	232	260	285	307	328
		H. P.	3.9	7.3	11.1	15.3	20.4	25.8	35.1
		Cu. Ft.	23250	28600	32900	36750	40250	43450	46450
140	7	R. P. M.	140	172	199	223	243	264	282
		H. P.	5.3	10.0	15.3	21.3	27.9	35.1	42.3
		Cu. Ft.	31550	38600	44600	49800	54550	58950	62950
160	8	R. P. M.	123	151	175	195	213	230	246
		H. P.	7.0	13.0	20.0	28.0	36.7	46.4	56.8
		Cu. Ft.	40850	50000	57750	64550	70650	76300	81550
180	9	R. P. M.	110	134	154	172	189	205	219
		H. P.	8.8	16.1	25.0	34.8	45.6	57.5	70.4
		Cu. Ft.	53200	63950	73750	82500	90350	97560	104250
200	10	R. P. M.	98	121	139	156	170	184	197
		H. P.	11.0	20.3	31.1	43.5	57.1	72.0	88.0
		Cu. Ft.	64100	78500	90600	101300	110950	119800	128000

* For schools, churches, etc., reduce capacity and horse-power 20 per cent for given speed. For shops and factories reduce capacity and horse-power 40 per cent for given speed.

COPYRIGHT, 1908, THE INDUSTRIAL PRESS NEW YORK

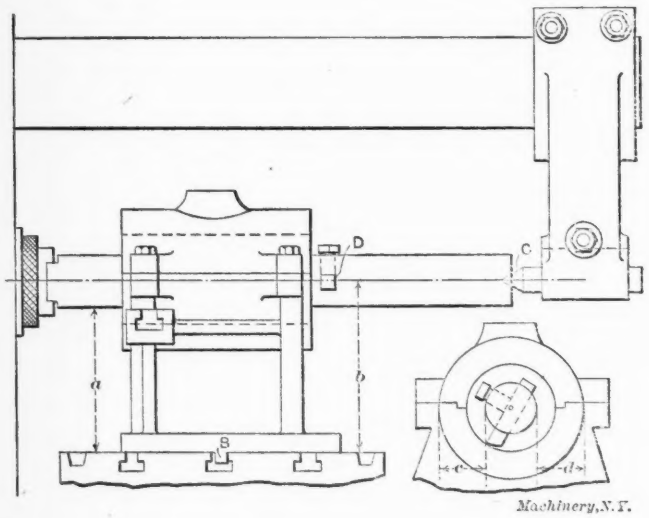
COPYRIGHT, 1908, THE INDUSTRIAL PRESS NEW YORK

Supplement to MACHINERY, June, 1908.

Operations for the Article in this number entitled "Machine Shop Practice—Machining a Fixture Casting."

SHOP OPERATION SHEET NO. 64.

H. A. S. Howarth. MACHINERY, June, 1908.



To Set Up and Bore a Fixture Bearing in a Milling Machine.

1. Set up the fixture on the milling machine table with the tongue *B* against one side of a T-slot, and clamp the fixture in place. Put the boring-bar in the spindle.

2. Be sure that the center *C* lines up with the end center of the bar. While it is free, test the end of the bar by revolving the spindle slowly, using an indicator to detect any error. If the bar runs true, the center *C* must be set so that as it enters the center of the bar it does not spring it.

3. Set the table vertically so that the height *a* of the under side of the bar above the table, added to half the diameter of the bar, will equal the distance *b* from the center of the bearing of the fixture to its base.

4. Set the bar central with the bosses on the ends of the bearing, making the distances *c* and *d* equal. Clamp the knee and table, leaving the cross feed free.

NOTE.—The power cross feed of the machine should be greater, by at least two inches, than the length of the bearing to be bored. The boring tool *D* must be so located that it will pass clear through the bearing and extend far enough out at either end to be adjusted readily.

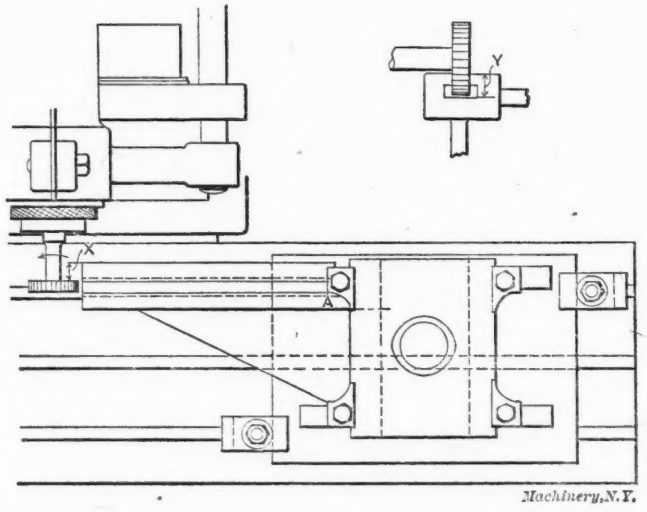
5. Set the tool point so that it will just clear the rough interior of the bearing as it passes through, and note the places where the cut will be heaviest. Set the tool to take as heavy a cut as is safe, and take a roughing cut.

6. Take the cuts in both directions when practicable. The last few cuts should be very light, removing from 0.002 to 0.004 of an inch. The finishing cut should just scrape the hole smooth.

7. Remove the bar, unclamp the knee and the table, but leave the fixture set up for the next operation.

SHOP OPERATION SHEET NO. 65.

H. A. S. Howarth. MACHINERY, June, 1908.



To Mill a T-slot. First Operation.

NOTE.—It is assumed that the fixture bearing was left set up on the milling machine table on the completion of the last operation.

1. Insert the shank of the milling cutter into the spindle of the machine. The cutter and shank may be solid, or the cutter may be mounted on an arbor and held in place by a key and nut. The diameter of the shank or arbor next to the cutter should be small, so as to permit the use of a small cutter; this will enable the cut to be run close up to the bearing as at *A*.

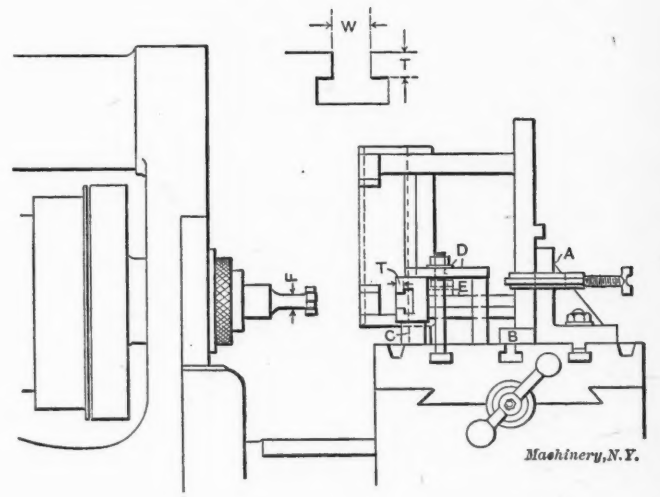
2. Adjust the table of the machine so that the cutter will be set as shown in the illustration, the distance *X* being equal to the required dimension. The depth of the cut should be equal to the depth *Y* of the T-slot.

3. Start the machine and mill the slot to the required width and depth in one cut unless the width of the slot needs to be very accurate, when two cuts may be taken, the one with a roughing, and the other with a finishing cutter. The cutter in this instance should be rotated as indicated by the arrow, as the work will then be fed against the cutter, and all slack or back lash between the nut and the feed-screw will be taken up.

NOTE.—By using an end mill, this operation could be done at the next setting of the fixture, but the foregoing method is preferable, as a very slow feed must be used with the end mill to keep it from springing. Then again, it is essential that this part of the T-slot be exactly in line with the tongue on the base of the casting, and exactly square with the bore of the bearing; therefore, it is better to partially mill the T-slot at this setting.

SHOP OPERATION SHEET NO. 66.

H. A. S. Howarth. MACHINERY, June, 1908.



To Mill a T-slot. Last Operation.

1. Remove the bearing cap from the fixture so that it will not be in the way when finishing the T-slot. The slot is supposed to have been finished to the width *W*, as described in the previous operation.

2. Bolt an angle plate *A* to the milling machine table, placing the tongue on the plate against one side of a T-slot.

3. Set up the fixture as shown, with its planed edge resting on a parallel *B*. Clamp the base to the angle plate with C-clamps, and insert blocks *C* under the casting, one beneath the end of the bearing, and another near the end of the slotted arm. These blocks should just fill the space between the table and the casting. With the clamps *D* and *E*, fasten the work securely to the table, and then, using a square, test the base of the casting to see if it is square with the table.

4. Insert a standard T-slot cutter into the spindle of the machine. The diameter *F* of the shank of the cutter should be slightly less than the width *W* of the T-slot. The cutter itself should be of a size to finish the T-slot at one cut.

5. Adjust the table of the machine so that the cutter will be central with the slot which was milled during the previous operation, and also so that the cutter will mill the T-slot to the required thickness *T*.

6. Start the machine, and feed the cutter through the slot carefully. As a T-slot cutter is somewhat delicate, and as it is almost wholly surrounded by metal during the cut, a moderate feed and speed should be used to prevent springing and overheating the cutter.

NOTE.—For very accurate work, first a roughing and then a finishing cutter should be used.